MONITORING & QUALITY MANAGEMENT PLAN/ QUALITY ASSURANCE PROJECT PLAN FOR MARKWEST'S HARMON CREEK PROCESSING PLANT AIR TOXICS MONITORING STATIONS

Prepared for:

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By

MSI Trinity Consultants

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A PROJECT MANAGEMENT ELEMENTS

A.1 Approvals Signatures

_____ Date:_____
MarkWest Facility Coordinator, Phillip Jereza

_____ Date:_____
MarkWest Program Manager, Robert McHale, P.G

_____ Date:_____
EPA Region 3 Air Monitoring Project Manager

_____ Date:_____
EPA Region 3 Quality Assurance Coordinator

_____ Date:_____
MSI Trinity
Project Director, Casey Lenhart

_____ Date:_____
MSI Trinity
Project Quality Assurance Officer, Linda Conger

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A.3 Distribution List

The following individuals have been provided a copy of this Quality Management Plan (QMP) and Quality Assurance Project Plan (QAPP).

Table A-1 Distribution List for QMP/QAPP

Personnel	Organization	Email Address	Business Address	Telephone Number
Jake Fournier	MarkWest	jrfournier@marathonpetroluem.com	Marathon Petroleum 539 South Main Street Room 4687 Findley, Ohio 45840	(419) 672-6662
Phillip Jereza	MarkWest		4600 J. Barry Ct. Suite 500 Canonsburg, PA 15317	
Robert McHale	MarkWest	robert.mchale@markwest.com	4600 J. Barry Ct. Suite 500 Canonsburg, PA 15317	(724) 416-0135
	EPA Region 3			
Casey Lenhart	MSI Trinity	ccl@metsolution.com	MSI Trinity 4525 Wasatch Blvd., Suite 200 Salt Lake City, Utah 84124	(801)-272-3000 Ext. 307
Linda Conger	MSI Trinity	lec@metsolution.com	MSI Trinity 4525 Wasatch Blvd., Suite 200 Salt Lake City, Utah 84124	(801)-272-3000 Ext. 305

A.4 Project/Task Organization

MarkWest is committed to quality and the implementation of the procedures and practices found in this Quality Assurance (QA) Project Plan. Quality Assurance (QA) is an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed, and expected. Quality Control (QC) is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer. The QC system includes the operational techniques and activities that are used to fulfill requirements for quality.

Quality control is largely implemented through the QA Program Plan. Each monitoring program has unique requirements, statutory guidelines, rules, and policies that must be followed. The QAPP incorporates the unique qualities that are specific to each monitoring program.

Implementation of a quality program requires a management system available to all Project Managers. MarkWest and its subcontractors are committed to the principles and practices of its QA Program at the highest level. Senior management recognizes and accepts this responsibility to identify the quality requirements that will meet needs and expectations of the monitoring program. The QA Program developed for this program focuses on preventing quality problems.

The following sub-sections describe the project participants and the roles and responsibilities of each participant.

A.4.1 MarkWest Facility Coordinator

The MarkWest representative, Mr. Phillip Jereza, is the facility coordinator who will coordinate and insure the implementation of the air toxic and meteorological monitoring program at the Harmon Creek Gas Processing Plant.

A.4.2 MarkWest Program Manager

The MarkWest representative, Mr. Robert McHale P.G. is with corporate environmental services and will serve as the program manager who is responsible for oversight of the speciated VOC monitoring program. Mr. McHale has overall responsibility for the project including contractor, EPA liaison, technical quality of work performed, and budget and schedule management. Mr. McHale is the person responsible for the allocation of resources and funds on behalf of MarkWest to ensure compliance with the QAPP and to ensure the data collected at the sites meet all quality assurance requirements. Mr. McHale will coordinate with the Harmon Creek facility manager for this project as well as its subcontractor in the performance of the work needed to obtain quality and accurate speciated VOC and meteorological data. Mr. McHale is independent of the monitoring being performed at the Harmon Creek facility. In the extremely rare case that a project dispute arises, the Program Manager will address the issue with the Facility Coordinator, contractor, and, if necessary, involve EPA Region 3 representative to help resolve the dispute.

A.4.3 EPA Region 3 Air Monitoring Project Manager

EPA Region 3 will assign an ambient project manager who will provide project oversight.

A.4.4 EPA Region 3 Quality Assurance Coordinator

EPA Region 3 will assign a Quality Assurance Coordinator who will direct all quality assurance activities as related to the air toxics and meteorological monitoring program at the Harmon Creek Gas Processing Plant.

A.4.5 MSI Trinity Project Director

At MSI Trinity, MarkWest's chosen subcontractor, the Director of Monitoring Services is ultimately responsible for all quality-related functions. His QA responsibilities are to authorize the issuance of QA policy, direct implementation of QA objectives, plans, and policies, appointing of the QA Director who directs the QA program, and approves the QA implementation strategy. In addition, as Director of Monitoring Services, Mr. Lenhart has overall responsibility for the project, including client liaison, planning document preparation, technical quality of work performed, data acquisition, report preparation, as well as budget and schedule management. Mr. Lenhart will be responsible for determining the staff assigned to the project understand and comply with the QC procedures that apply to their activities. He will be responsible for overseeing the day-to-day operation, routine and preventive maintenance, data collection and data validation activities. He will communicate with the client for feedback and ensure that project deliverables and activities are in accordance with project requirements. Mr. Lenhart will respond to corrective action requests and assure that deficiencies are corrected in a timely manner. Mr. Lenhart will coordinate with the quality assurance officer with implementing the quality management program designed for this monitoring program.

Mr. Lenhart will be responsible for training of all field and data staff involved with this project and documentation of training is maintained in the individual's personnel file which is kept at MSI Trinity. The training includes hand-on equipment operation teaching, both in the field and laboratory, and periodic re-assessment of instrumentation staff skills. If additional training is needed, Mr. Lenhart will be responsible for ensuring that training is obtained through MSI Trinity or from an outside vendor.

The Project Director is the primary link between MSI Trinity and MarkWest and is responsible for furnishing a service that meets the functional, technical, cost, and schedule requirements of the project. The Project Director is assisted by the technical staff.

MSI Trinity recognizes the importance of strong project management skills and their applications. MSI Trinity project management training activities provide Project Directors and Managers with tools to help them perform effectively through all stages of a project. The training is designed to assist with time management, communication skills, and to help he or she be responsive to clients, manage budgets and schedules, lead project teams, and meet the desired quality standards of the work.

The Project Director is assisted by the technical staff including instrumentation specialists, Mr. Mike Peterson, Mr. Tyler Ward, Mr. Reed Manes, Mr. Tomy St. Laurent, Mr. Adam Lenkowski and/or Mr. Isaac Legare who will perform equipment installation, routine maintenance and quarterly ambient air quality analyzer calibrations, and semi-annual meteorological sensor calibrations. The field technicians report to the MSI Trinity Project Director. MSI Trinity field technicians have the requisite background and training needed to perform their assigned tasks.

MSI Trinity recognizes the importance of strong project management skills and their applications. MSI Trinity project management training activities provide Project Directors with tools to help them perform effectively through all stages of a project. The training is designed to assist with time management, communication skills, and to help he or she be responsive to clients, manage budgets and schedules, lead project teams, and meet the desired quality standards of the work.

A.4.6 MSI Trinity Quality Assurance Officer

The QA Director manages the QA Program and is responsible for the technical quality of all work products at MSI Trinity and the development and maintenance of a sufficient level of technical resources to support the company's objectives. The QA Director reports to the Director of Monitoring Services and has the authority to halt the transmittal of any work product that in her opinion is not consistent with MSI Trinity's quality standards.

The QA Director's primary duties are: (1) To provide a central point of responsibility for assessing company-wide technical strengths, needs and direction to maintain a consistent Company-wide quality of work that meets or exceeds the current standard of practice; (2)To develop MSI Trinity QA policy; (3) Coordinate training; (4) Provide guidance to the QC reviewers in carrying out QC-related functions; (5) Inform project personnel of QA policies, procedures, and other guidance documents; (6) Prepare the QA Project Plan; (7) Audit selected projects and monitoring general compliance with the QA policy; (8) Advise Project Directors of deficiencies on peer reviews and identify corrective action needs; and (9) Maintain MSI Trinity QA files, including audit reports.

The responsibility for planning, developing, and implementation the Quality System resides with MSI Trinity's Quality Assurance (QA) director, Ms. Linda Conger. The QA director reports to the Director of Monitoring Services. Ms. Linda Conger is responsible for oversight of MSI Trinity's quality assurance/quality control activities from field measurements to data validation, data reporting, and implementation of quality assurance policies and procedures. She is responsible for ensuring that each staff member involved with collecting or analyzing environmental data has the necessary technical, quality assurance, and project management training required for his or her assigned tasks and functions.

Ms. Conger will prepare and maintain the official approved QA Project Plan. The QA Project plan and standard operating procedures prepared and submitted with the plan are reviewed and updated annually or when significant changes are made to the monitoring equipment or methodologies utilized.

The QA project plan is reviewed by the Project Director. When finalized by the QA director, the QA project plan is signed by senior management staff and program participants. All appropriate personnel in the organizations performing or reviewing work covered by the scope of the QA project plan are notified through email, meeting, or via telephone of changes to the quality system so they are informed of current requirements.

Field or data issues are brought to the Project Directors attention who will inform the QA Director is changes are necessary. Oversight responsibilities for QA/QC may result in disagreements between the oversight group and the program reviewed. Such disputes may occur in situations involving technical issues (e.g., quality requirements, assessments, audits, surveillance, data and technical information) and management issues. All parties will make every effort to resolve disputes through discussion and negotiation. If the parties are unable to resolve the dispute, final resolution will be initiated by the QA Director with concurrence from the Director of Monitoring Services.

Ms. Conger will be assisted in quality related activities on this project by Mr. Scott Adamson, CCM. Mr. Adamson reports to the Project Director but also maintains a direct communication link and reporting relationship with the QA Director on quality-related matters. Any non-conformance with QC procedures identified by Mr. Adamson will be reported to the Project Director and QA Director, along with recommended corrective measures for implementation.

Mr. Adamson has been assigned to perform quality control of data collection, data validation and reporting. He will review all data with respect to QC criteria and will communicate review comments to project team members. Mr. Adamson has the requisite background and training needed to perform QA/QC activities. Documentation of all formal training is maintained in the individual's personnel file which is kept at MSI Trinity.

A.4.7 MSI Trinity Field Technicians/Calibration

Mr. Mike Peterson will perform the equipment installation, routine maintenance and instrument calibrations. He will be assisted by Mr. Adam Lenkowski, Mr. Isaac Legare, Mr. Reed Manes, Mr. Tomy St. Laurent, or Mr. Tyler Ward, as necessary.

A.4.8 Site Operator

The site operators, MarkWest personnel and MSI Trinity technicians, will be responsible for conducting routine and preventative maintenance and troubleshooting.

A.4.9 MSI Trinity Data Management

Mr. Brian Olsen and/or Mr. Wyndam Lewis are MSI Trinity's data managers who will be responsible for ensuring timely data collection, posting data for review and preparation of data summaries for reports. Final data validation is the responsibility of the MSI Trinity Project Director, the reviewing meteorologist or air quality specialist, and the quality assurance officer.

A.4.10 Quality Assurance Performance Audits

The quality assurance performance audits for this project will be conducted by an independent auditor.

Figure A.1 presents the organizational chart that shows the lines of responsibility and information flow for activities under this project.

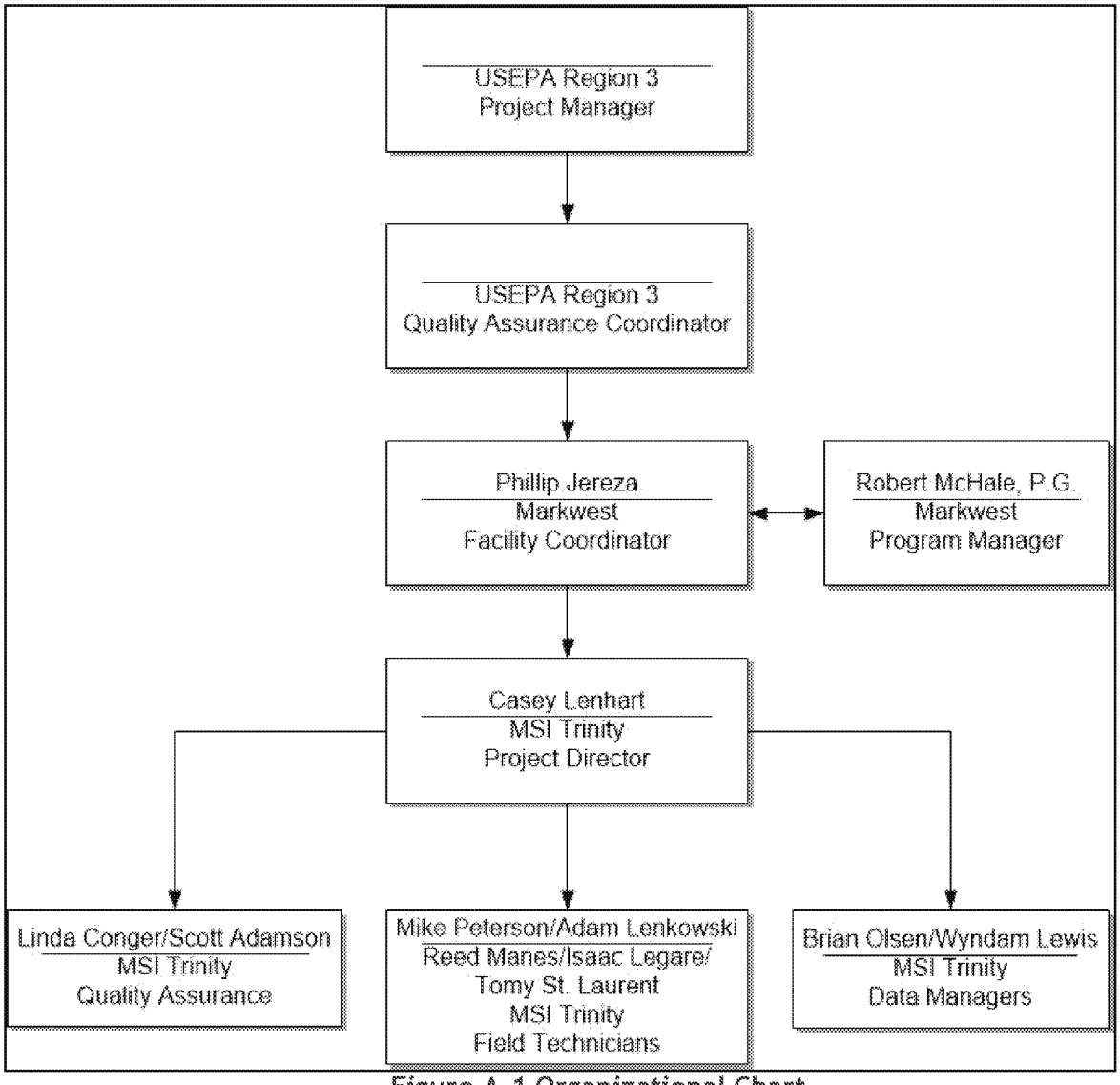


Figure A.1 Organizational Chart

An annual review of the quality management and quality assurance project plans will be performed and, if changes are required, revised pages with the revisions will be submitted to the MarkWest for review and approval.

A.5 Problem Definition/Background

Pursuant to Section VI of the Consent Decree, a fence line monitoring system (FLMS) will be installed, operated, and maintained at the Harmon Creek Facility to measure ambient concentrations of propane, butane, pentane, hexane, benzene, toluene, ethylbenzene, xylene and all of its isomers, and total VOC's. In addition, meteorological measurements are required to be collected during all periods of time.

This quality assurance project plan has been prepared on behalf of the MarkWest and details the methodologies to establish continuous and accurate air toxic and meteorological measurements at the Harmon Creek Gas Processing Plant. This monitoring will be conducted to satisfy the requirements of the Consent Decree. The primary objective of this monitoring site is to characterize upwind and downwind concentrations of propane, butane, pentane, hexane, benzene, toluene, ethylbenzene, xylene and all of its isomers, and total VOC's in the vicinity of the Harmon Creek Gas Processing Plant. In addition, a meteorological tower will be located adjacent to the upwind shelter to collect meteorological measurements at the facility. The monitoring will be performed in accordance with EPA's Technical Assistance Document for the National Air Toxics Trends Stations Program, Revision 3 and EPA's Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, TO-15.

MarkWest has contracted MSI Trinity to establish and operate the Harmon Creek Gas Processing Plant monitoring stations including equipment procurement, equipment installation, calibration of the monitoring equipment, routine operation, daily data collection and system operational checks, quality control checks, data management, data validation, and reporting. Monitoring data will be collected to document air toxics and meteorological parameters in conformance with US EPA Special Purpose Monitoring (SPM) requirements.

The procedures outlined in this QAPP have been developed to meet the goals and objectives of the monitoring project. Revisions to the QAPP are made, as necessary, to reflect changes to the regulations or goals of the monitoring project. As a minimum, the QAPP is reviewed annually and revisions are made as necessary.

The information collected for this monitoring program will meet the requirements as found in the following documents:

- EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, EPA-454/B-17-001, January 2017;
- EPA's Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, TO-15;
- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards;
- EPA's Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV, Meteorological Measurements, EPA March 2008; and,
- EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005, February, 2000.

The guidance presented in the above listed documents and to be followed for this monitoring program is intended to ensure that data and technical information that are measured are of documented and appropriate quality and usability.

A.5.1 Area Climate and Topography

The following sections describe the climate and topography around Harmon Creek Gas Processing Plant.

A.5.1.1 Climate

The climate around the Harmon Creek Gas Processing Plant is characterized by relatively mild temperatures and evenly distributed precipitation throughout the year. Temperatures are warm, with July, on average being the warmest month with an average high temperature of 82.0°F. Winter temperatures range from an average high of 40°F in December to 38°F in February. On average, January is the coldest month.

Summers are usually somewhat wetter than winters, with much of the rainfall coming from convectional thunderstorm activity; remnants of hurricanes or tropical storms can also enhance rainfall. The average amount of precipitation for the year in Joffre Pennsylvania is 40.2 inches per year. The average snow fall for the year is 29.5 inches.

Table A-2 presents the monthly climatic summary for Joffre, Pennsylvania.

Table A-2 Monthly Climatic Summary for Joffre, Pennsylvania

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Max. Temp. (°F)	35.0	38.0	49.0	60.0	71.0	78.0	82.0	81.0	75.0	63.0	52.0	40.0
Avg. Min. Temp. (°F)	14.0	15.0	24.0	33.0	42.0	51.0	56.0	55.0	49.0	37.0	30.0	22.0
Avg. Total Prec.[1] (in)	2.72	2.52	3.03	3.03	4.21	4.17	4.33	4.06	3.35	2.76	3.15	2.87

[1] Average precipitation data obtained for Burgettstown, PA. Source of Data: usclimatedata.com.

A.5.1.2 Topography

The local topography around the Harmon Creek Gas Processing Facility consists of primarily trees and rolling hills.

A.6 Project/Task Description

The air toxic analyzers and meteorological sensors installed at the Harmon Creek monitoring stations meet Consent Decree monitoring requirements. The operating range of the sensors and monitors easily bracket the range of environmental conditions expected at the site. Harmon Creek Air Quality and Meteorological Monitoring Stations.

Air toxic measurements consisting of C2 to C6, i.e., from ethane through 1,3-butadiene up to benzene, and up to 32 compounds from C6 to C12 (hexane, dimethylbutane, diethylbenzene, naphthalene, dodecane, BTEX, and halogen compounds) will be continually monitored at three stations, one upwind and one downwind station located nearby the Harmon Creek Gas Processing Plant Facility and a second downwind station located approximately three kilometers downwind of the gas plant. In addition, meteorological measurements will be collected from a 10-meter tower which will be located at the upwind station. These continuous measurements will consist of wind speed, wind direction, temperature, relative humidity, and barometric pressure.

The air quality and meteorological monitoring stations will be located at the Harmon Creek Gas Processing Plant which is approximately 2.1 miles northeast of Joffre, Pennsylvania. The latitude/longitude coordinates and elevations of the upwind and downwind monitoring stations in WGS 84 are:

Latitude (decimal degrees)	Longitude (decimal degrees)	Elevation (feet)
Upwind Station & Meteorological Tower		
40°.402706	80°.359403	1,033
Near Downwind Station		
40°.405192	80°.357383	1,036
Far Downwind Station		
40°.403778	80°.325667	1,013

The Harmon Creek monitoring stations were selected to be as representative as possible to the general region of interest. Meteorological data from Pittsburgh International Airport (KPIT) was used to determine the general wind flow patterns in the area to place the stations in upwind and downwind locations. Placement of monitors considered local interferences, distance to structures, trees, and roadways, and height of probe above ground. The network was set up in accordance with EPA-defined ambient air quality and meteorological siting criteria.

Monitoring station locations were selected to be at least 20 meters from the dripline of any trees and a distance of at least twice the height that any obstacles (buildings or structures) protrude above the sampler, probe, or monitoring path.

A map presenting the location of the proposed Harmon Creek Gas Processing Plant is presented in Figure A.2. A closer-in Google Earth image showing the locations of the monitoring stations around the facility is presented in Figure A.3.

Photographs taken in the cardinal directions from the upwind and two downwind stations are presented as Figures A.4 through A.15.

Figure A.2 Location of Harmon Creek Gas Processing Plant

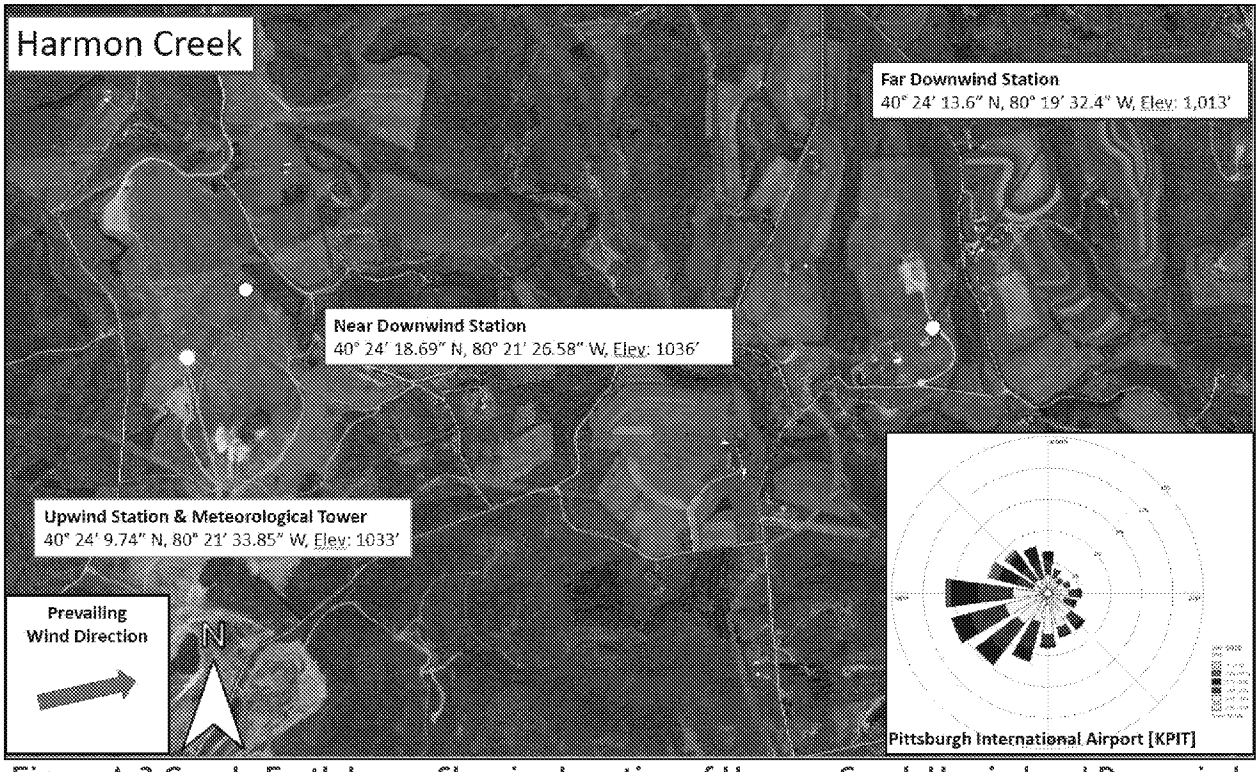


Figure A.3 Google Earth Image Showing Location of Harmon Creek Upwind and Downwind Monitoring Stations

Figure A.4 Photograph from the Proposed Upwind Station Looking East

Figure A.5 Photograph from the Proposed Upwind Station Looking West

Figure A.6 Photograph from the Proposed Upwind Station Looking North

Figure A.7 Photograph from the Proposed Upwind Station Looking South

Figure A.8 Photograph from Proposed Near Downwind Station Looking East

Figure A.9 Photograph from Proposed Near Downwind Station Looking West

Figure A.10 Photograph from Proposed Near Downwind Station Looking North

Figure A.11 Photograph from Proposed Near Downwind Station Looking South

Figure A.12 Photograph from Proposed Far Downwind Station Looking East

Figure A.13 Photograph from Proposed Far Downwind Station Looking West

Figure A.14 Photograph from Proposed Far Downwind Station Looking North

Figure A.15 Photograph from Proposed Far Downwind Station Looking South

A summary of the air quality and meteorological instrumentation to be installed at the Harmon Creek monitoring stations is presented in Table A-3.

Table A-3 Harmon Creek Meteorological and Air Quality Monitoring Equipment

Parameter	Manufacturer/Model	Units/Range of Measure
Air Toxics	Consolidated Analytical Systems (CAS) AirmOzone Auto-Gas Chromatographs (GCs)	C2 to C6 - 0.033 to 500 µg/m^3 of 1,3-butadiene with a lower detectable limit of 15 ppt for 1,3-butadiene C6-C12 - 0.05 to 400 µg/m^3 for tri-methylbenzene with lower detectable limits of 10 ppt for tri-methylbenzene and 10 ppt for benzene
Meteorological		
Wind Speed	RM Young Model 05305-5	0 - 50 m/s
Wind Direction	RM Young Model 05305-5	0 – 360 degrees
Temperature	Campbell Scientific EE181	-40 to 60°C
Relative Humidity	Campbell Scientific EE181	0 – 100%
Barometric Pressure	Vaisala PTB110	500 – 1100 hPa
Data Storage	Campbell Scientific CR1000X	NA

A.6.1 Sampling Frequency

Data from the instruments listed in Table A-3 will be collected and stored by Campbell Scientific CR1000X data loggers. Air toxic monitor data will be recorded as 10-minute averages. Meteorological data are sampled every second and recorded as five-minute averages on the data logger.

A.6.2 Project Schedule

Upon approval, MarkWest anticipates three months will be required to purchase equipment, six months to install and integrate, and three months to finalize site and power logistics, acceptance test all instrumentation, and begin operation.

Personnel working on this project will be fully qualified, trained, and capable to perform their assigned duties. Work schedules include: daily data review; quarterly and semi-annual air quality and meteorological equipment calibrations, respectively; quarterly data summaries within 60 days of quarter completion; and maintenance and corrective action, as needed. Table A-4 presents the project schedule.

Table A-4 Project Schedule

Task	Time
Monitoring Plan Update	Start of contract and as needed to reflect changes in equipment or monitoring requirements.
Monitoring Operations	Calibrations – start of contract; semi-annually for meteorological sensors, quarterly for air quality analyzers, and whenever an instrument exceeds specified control limits or undergoes major maintenance or repair.
Quality Assurance	One air quality and meteorological audit will be conducted annually by the independent auditor.

A.6.3 Project Reports

Table A-5 presents the reports that will be produced as part of this project.

Table A-5 Project Reports

Reports	Frequency	Content	Responsible Position	Distribution
Quarterly Air Quality and Meteorological Data Summaries (Includes accuracy and precision)	Quarterly	Summarize data following EPA guidelines	Brian Olsen/ Wyndam Lewis MSI Trinity Data Managers	See Section A.3 Distribution list
Corrective Action Reports	As Needed	Summarizes corrective actions taken to return the monitoring station to compliant status	Casey Lenhart MSI Trinity Project Director	See Section A.3 Distribution list
Response to Corrective Action Reports	As Needed	Reports the results of the corrective actions taken	Casey Lenhart MSI Trinity Project Director	See Section A.3 Distribution list

A.7 Quality Objectives and Criteria for Measurement of Data

Presented in this section are the Measurement Quality Objectives (MQOs) for the air toxic and meteorological measurements. MQOs are designed to evaluate and control various phases (sampling, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the data quality objectives. MQO's can be defined in terms of the following data quality indicators: detection limits; precision; accuracy; bias, representativeness; detectability; completeness; and comparability. Monitoring results are assessed against these objectives to demonstrate the quality of measurement data.

Detection limits are expressed in units of concentrations and reflect the smallest concentration of a compound that can be measured with a defined degree of certainty. The detection limit for each VOC will be estimated according to 40 CFR Part 136, Part B. For the continuous gas chromatographs, if a compound is detected at or above its method detection limit (MDL), there is at least a 99 percent certainty that the compound concentration is greater than zero. The detection limit of the auto-GC target compounds is 0.5 ppbC.

Precision is a measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions. This is the random component of error. Precision is estimated by various statistical techniques typically using some deviation of the standard deviation. For VOC measurements, AutoGC precision will be estimated by comparison of replicate measurements of the daily QC standard. The precision of the auto-GC target compounds is 15-25%.

Bias is the systematic or persistent distortion of a measurement process which causes error in one direction. Bias will be determined by estimating the positive and negative deviation from the true value as a percentage of the true value. The bias for the auto-GC target compounds is 25%.

Accuracy is the closeness of a measurement reference value and includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. The accuracy will be estimated by independent performance audits.

Representativeness is the extent to which a set of measurements reflect actual conditions for a specific application. The siting criterion in 40 CFR Part 58 will be met, where possible.

Detectability is the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability.

Completeness describes the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions. Completeness for this air toxics monitoring program is 85%.

Comparability is a measure of the confidence with which one data set or method can be compared to another, considering the units of measurement and applicability to standard statistical techniques. Comparability of datasets is critical to evaluating their measurement uncertainty and usefulness.

The EPA has developed a Data Quality Objective (DQO) seven-step process for use in environmental measurement projects. Table A-6 summarizes this process. The benefits of the DQO process are that it prompts a statement of the problem, identifies the decisions to be made and the inputs needed to make the decisions, and specifies a decision rule.

Table A-6 Data Quality Objective Process for Ambient Monitoring Project

Step 1	Define the Problem	MarkWest will collect ambient 1-hour air toxic data
Step 2	Identify the Goal of the Study	EPA will use data to determine fence line air toxic concentrations around the Harmon Creek processing facility
Step 3	Identify Information Inputs	Ambient measurements will be made at an EPA-approved monitoring sites
Step 4	Define the Study Boundaries	Sampling frequencies are discussed in Section A.6.3; sampling location is presented in Section A.6.2.
Step 5	Develop the Analytical Approach	The measured ambient air toxic concentrations and meteorological data will be determine fence line air toxic concentrations that may pose a public health hazard
Step 6	Specify the Limits of the Decision	The site operator will demonstrate that the instrument system is capable of measuring speciated VOC with an accuracy of 15% of the true value on a regular basis.
Step 7	Develop the Plan for Obtaining Data	If the system does not conform to the required QA/QC protocols identified in this document, the site operator will initiate corrective action to bring into conformance.

For the monitoring project, the air toxic MQOs are presented in Tables A-7 and A-8; the meteorological MQO's are presented in Tables A-9 and A-10. The AutoGC used for the air toxics monitoring utilizes internal permeation calibration devices which are traceable to the initial NIST calibration standard. Meteorological equipment calibration and accuracy criteria are presented in Table A-11.

The general air toxic project objectives are to: (1) provide measurements of selected pollutants to be used in evaluating population exposure to these pollutants, and (2) provide a speciated database that is both representative and useful for ascertaining ambient profiles and distinguishing among various individual VOCs.

Meteorological measurements recorded are subject to and consistent with the quality assurance requirements as found in the following documents:

- EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV*, Meteorological Measurements, EPA March 2008; and
- EPA's Meteorological *Monitoring Guidance for Regulatory Modeling Applications*, EPA-454/R-99-005, February, 2000.

Detection limits are expressed in units of concentration and reflect the smallest concentration of a compound that can be measured with a defined degree of certainty. For VOC's the detection limits reflect an estimate of the smallest volume of a compound that can be measured with a defined degree of accuracy.

For the continuous GC, is a compound is detected above its method detection limit (MDL), there is at least 99% certainty that the compound concentration is greater than zero.

Measurements that do not meet the MQO's will be invalidated unless justification can be identified for not doing so. In addition, data will be invalidated if a sensor/analyzer fails a performance audit and further investigation confirms the audit results. These data will be invalidated back to the last good check or calibration of the equipment. Bias for the meteorological measurements will be determined based on performance audit results.

Table A-7 Air Toxic Measurement Quality Objectives

Parameter (Manufacturer/ Model)	Requirement	Frequency	Acceptance Criteria	Data Completeness
Air Toxics CAS AutoGC	Internal Calibration	Daily	<±10%	85%
	Precision of results for internal standards	Weekly	≤15%	

Table A-8 Air Toxic Measurement Methods and Response Characteristics

Parameter	Measurement Method	Analyzer Response Characteristic
AirToxics	Auto-Gas Chromatograph	Compounds Analyzed – Light VOC analysis: C_2 to C_6 from Ethane through 1,3-Butadiene up to Benzene (and other C compounds) Up to 32 compounds from C_6 to C_{12} - C_6 (Hexane, Dimethylbutane) to C_{10} (Diethylbenzene, Naphthalene) and dodecane, BTEX, halogen compounds (TO-14) Detection Ranges C_2 to C_6: 0.033 to 500 µg/m of 1,3-Butadiene C_6 to C_{12}- 0.05 to 400 µg/m for tri-methylbenzene Lower Detectable Limits: C_2 to C_6 – 15 ppt for 1,3-Butadiene C_6 to C_{12} – 10 ppt Tri-methlybenzene; 10 ppt benzene Relative Standard Deviation: Concentration: RSD <3% over 48 hours Retention Time: RSD < 0.3% over 48 hours Sample Volume: C_2 to C_6 – 20 to 240 ml C_6 to C_{12} – 30 to 700 ml Operating temperature: 18 to 25°C Sample flow rate and pressure: 180 ml/min; 3 bars

Table A-9 Meteorological Measurement Quality Objectives

Parameter (Manufacturer/ Model)	Specified Accuracy	Required Accuracy	Sensor Resoln. in System	Required Resoln.	Data Complete.
Wind Speed RM Young Model 5305 Wind Monitor AQ	±0.2 m/s or 1% of reading	±0.25 m/s ≤5 m/s ±5% >5m/s not to exceed 2.5 m/s	0.01 m/s	0.1 m/s	90%
Wind Direction RM Young Model 5305 Wind Monitor AQ	±3 degrees	±5 degrees including orientation error	0.01	1.0	90%
Temperature Campbell Scientific EE181	±0.2°C @ 20°C	±1.0°C	0.01°C	0.1°C	90%
Barometric Pressure PTB 110	±0.5 mb @ +20°C	±3 mb	0.01 mb	0.1	90%
Relative Humidity Campbell Scientific EE181	± (1.5 + 0.015 * RH reading) % RH @-40°C to 60°C	±7% RH	0.1%	0.5%	90%

Table A-10 Meteorological Measurement Methods and Response Characteristics

Parameter	Measurement Method	Sensor Response Characteristic	EPA-Required Response Characteristics
Wind Speed – RM Young Model 5305 Wind Monitor AQ	Propeller rotation produces AC signal with frequency output proportional to wind speed	Starting Threshold = 0.4m/s Distance Constant =2.1m	Starting Threshold = ≤0.5m/s Distance Const. ≤m
Wind Direction - RM Young Model 5305 Wind Monitor AQ	Precision potentiometer	Starting Threshold = 0.5m/s @10° displacement Delay Distance = 1.2 m Damping Ratio = 0.45	Starting Threshold ≤0.5m/s Delay Distance ≤5m Damping Ratio=0.4 to 0.7
Temperature - EE181	1000 Ω Platinum Resistance Thermometer	Time Constant ≤1 minute	Time Constant ≤1 minute
Barometric Pressure PTB 110	Silicon capacitive sensor	Response Time <100 ms	NA
Relative Humidity - EE181	Humidity Capacitive Sensor	Response Time <2 sec	≤30 minutes

Table A-11 Meteorological Measurement Calibration and Accuracy Criteria

Parameter	Calibration			Accuracy		
	Type	Acceptance Criteria	Frequency	Type	Acceptance Criteria	Frequency
Wind Speed	NIST-traceable synchronous motor	±.2 m/s ≤ 5m/s ±5%>5m/s not to exceed 2.5 m/s	6 month intervals	NIST-traceable synchronous motor	±.2 m/s ≤ 5m/s ±5%>5m/s not to exceed 2.5 m/s	Within 60 days of startup and 6 month intervals
Wind Direction	Compass System Orientation plus linearity	±5°	6 month intervals	Compass System Orientation plus linearity	±5°	Within 60 days of startup and 6 month intervals
Temperature	3 pt. water bath with NIST-traceable thermometer	±1.0°C	6 month intervals	3 pt. water bath with NIST-traceable thermometer	±1.0°C	Within 60 days of startup and 6 month intervals
Relative Humidity	Collocated NIST-certified RH sensor	±10%RH	6 month intervals	NIST- certified RH sensor	±10% RH	Within 60 days of startup and 6 month intervals
Barometric Pressure	NIST-traceable reference barometer	±3 mb or ±2.25 mmHg	6 month intervals	NIST-traceable reference barometer	±3 mb or ±2.25 mmHg	Within 60 days of startup and 6 month intervals

A.7.1 Representativeness of Air Toxics and Meteorological Measurements

Site selection and probe placement followed guidelines in the following US EPA documents to assure that measurements are representative air quality and meteorological monitoring conditions near the Harmon Creek Gas Processing Plant:

- Consent Decree;
- 40 CFR Part 58, Appendix D;
- Technical Assistance Document for the National Air Toxics Trends Stations Program, Revision 3;
- 40 CFR Part 58, Appendix E, Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring;
- EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV, Meteorological Measurements*, March 2008; and,
- EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications*, EPA 454/R-99-005, February 2000.

The Harmon Creek monitoring stations were selected to be as representative as possible to the general region of interest. Placement of monitors considered local interferences, distance to structures, trees, and roadways, and height of probe above ground. The network was set up in accordance with EPA-defined ambient air quality and meteorological siting criteria.

Monitoring station locations were selected to be at least 20 meters from the dripline of any trees and a distance of at least twice the height that any obstacles (buildings or structures) protrude above the sampler, probe, or monitoring path.

A.7.2 Data Quality Indicators

Data quality indicators provide the structure for ensuring that the project data are quality data and meet the data quality objectives presented in Section B of this QAPP. These indicators include precision, accuracy, bias, completeness, and comparability of the measurements. Precision and accuracy will be determined based on the daily internal analyzer self-calibrations. Bias and accuracy will be determined based on the results of the independent performance audits.

The quality control data assessment statistics are calculated during the final data validation step. Concentration data are not corrected based on the results of the data assessment statistics.

The data recovery goal for the Harmon Creek monitoring project is 85% per calendar quarter. The calculation of percent valid is based on the number of valid measurements as compared to the number of possible measurements.

A.8 Special Training/Certifications

Personnel assigned to air toxics and meteorological monitoring activities will be thoroughly trained by the Monitoring Manager and the equipment vendor (Consolidated Analytical Systems) in the proper operation, calibration, and maintenance of the equipment to ensure continued collection of valid, representative data. Instrument manuals will be available at the monitoring sites. As new quality assurance requirements arise, additional training will be provided by the Monitoring Manager to all affected personnel involved with the monitoring activities. The Monitoring Manager will document the type of training conducted and when the training was performed. This documentation is kept in MSI Trinity's personnel file by employee. These personnel have met the educational, work experience, responsibility, and training requirements for their position. Ambient air monitoring professionals with several years of experience will have responsibility for conducting the significant quality control and quality assurance activities on site.

Should a change in quality assurance requirements be identified, the QA Director will schedule a meeting with the project staff and will review the proposed QA changes to be made. The Project Director will be responsible for overseeing the implementation of any QA-related changes. If additional training is required, the Project Director or his designee will perform the training or will authorize project participants to obtain the training from an outside vendor, if needed. In these meetings, an agenda will be prepared and will include the QA requirement changes, differences between current practices, and a discussion on the QA requirement implementation. All QA-related training will be documented, implemented, and communicated to all team members as changes are made.

As part of the air monitoring bidding process, MarkWest ensures that all contractors performing work on MarkWest's behalf are qualified to perform the work they are contracted to conduct. MarkWest personnel ensure that monitoring is performed according to Consent Decree and EPA regulatory requirements by contractors that are experienced and knowledgeable. MarkWest personnel review deliverables, observe the performance audits, and ensure that QMP/QAPP requirements are followed.

MSI Trinity, assisted by MarkWest personnel, will be the site operators for the Siloam monitoring stations. These operators will be trained in the proper operation, routine and presentative maintenance, and troubleshooting procedures. MSI Trinity will provide all required supplies and assistance.

A.9 Documents and Records

The air toxics and meteorological monitoring program is committed to fully documenting all activities related to data collection, analysis, validation, and reporting. Table A-12 contains a list of the records maintained by the air monitoring program. These records can be electronic, bound in notebooks, and/or forms that are used for specific applications. Difficulties encountered during sampling will be documented

and will clearly indicate the affected measurements.

Electronic records will be stored and archived at MSI Trinity's Salt Lake City office. All project files are backed up daily. In addition, weekly network backup occurs. The weekly backup network files are stored onto external hard drives which are stored off-site. Copies of the field logbook are kept by MSI Trinity QA personnel and are included as part of MSI Trinity's project specific file.

Table A-12 Documentation and Reports

Documentation Type	Frequency	Report Submission	Archive	Retention Period
Monitoring Data	Daily Downloads	MSI Trinity Data Manager	MSI Trinity Server (with backup)	> 5 years
Corrective Action	As needed	MSI Trinity Project Director	MSI Trinity	> 5 years
QAPP	Annually or more frequently, as needed	MSI Trinity QA Manager (See Distribution List in Table A-1)	MSI Trinity	> 5 years
Copies of Field Logbooks	After each site visit	MSI Trinity QA Personnel	MSI Trinity	> 5 years
Quarterly Reports	Quarterly	MarkWest	MSI Trinity	> 5 years

All corrective actions will be documented. Corrective action may be taken in response to an audit finding, a quality control check that does not meet a project acceptance criterion, or any other obvious malfunction in hardware or software. Documentation of any corrective action will show the nature of the deficiency, actions taken, and evidence gathered to verify resolution of the deficiency. Corrective actions and their resolutions are documented in the quarterly reports.

Primary data collection at the upwind and downwind monitoring stations will be accomplished through the use of CR1000X data loggers. Air toxic monitor data will be recorded as 10-minute averages. Meteorological data are sampled every second and recorded as five-minute averages on the data logger. Remote data management will be accomplished by remotely interrogating the monitoring site from MSI Trinity's Salt Lake City office daily to maximize data recovery and identify problems in a timely manner.

MSI Trinity will host a password-protected project web-site which would be updated after every successful download. The site will contain air toxics and meteorological chart graphics, daily minimum, maximums, and averages, quality assurance station notes, and wind and pollutant roses. Historical data will also be available for review from the web site.

Stacked parameter plots will be generated which consist of every data point downloaded since the last site interrogation and reviewed by a qualified meteorologist or air monitoring specialist for consistency and possible problems. These data will be reviewed on a daily basis to determine if the measurements appear normal as well as identify instrumentation problems in a timely manner.

Quarterly data reports will be compiled by MSI Trinity and submitted to the MarkWest no later than sixty (60) days after the end of each quarter. The following data and quality assurance results will be contained in the quarterly and annual summary reports:

- Monthly printouts with valid hourly, eight-hour, and daily averages.
- Monthly, quarterly, and annual wind roses.
- Reports on performance audits.
- Monthly and quarterly percent data recovery by parameter.
- Results of calibration and quality control checks.
- Problems and corrective actions/resolved.
- QAPP revisions, if necessary.

The QA Project Plan is a key component of the quality system developed for a project. The QA Project Plan is intended to ensure that the data an agency uses in its decision-making process has known and documented quality. The QA Project Plan and standard operating procedures prepared and submitted with the plan are reviewed and updated annually or when significant changes are made to the monitoring equipment or methodologies utilized.

The QA project plan is reviewed for accuracy and completeness by the Project Director and MarkWest personnel. MarkWest personnel, specifically Robert McHale with MarkWest will review and approve all contract deliverables before deliverables are submitted to the EPA as final documents. This review ensures that the contract technical and quality goals are met.

When finalized by the QA director, the QA project plan is signed by senior management staff and program participants. QAPP revisions will be forwarded to the individuals on the distribution list in electronic or hard-copy format. MSI Trinity's QA officer will be responsible for QAPP distribution. All monitoring data, reports and project documentation will be retained by MSI Trinity for a minimum of five (5) years.

B MEASUREMENT AND DATA ACQUISITION

This section describes the project design and implementation of the Harmon Creek Monitoring Project, including sampling methods, sample collection, data handling and analysis, quality control requirements, equipment testing, inspection, calibration, and maintenance, and managing and validating the data.

B.1 Sampling Process Design

The purpose for the air toxics and meteorological measurements is to provide a continuous record of ambient concentrations of propane, butane, pentane, hexane, benzene, toluene, ethylbenzene, xylene and all of its isomers, total VOC's, and atmospheric conditions in the vicinity of the Smith Township in Washington County, Pennsylvania to characterize the air quality at the fenceline of the Harmon Creek Gas Processing Plant. The monitoring methods and equipment implemented provide SPM quality air quality and meteorological data that can be used to insure compliance with the National Ambient Air Quality Standards (NAAQS).

MarkWest personnel rely on the skills and expertise of the contractor to design a monitoring program that meets the objectives and requirements of the monitoring program. System design and proposed monitoring equipment as well as the approach in conducting the monitoring is provided during the bidding process.

Probe siting information and site configuration for the monitoring are in accordance with 40 CFR Part 58, Appendix E. The instruments produce a signal transmitted to the data acquisition system where it is digitized and converted to engineering units and stored in electronic memory.

All measurements described in this QAPP are critical to achieve project objectives. Detailed site information with a map of the monitoring site is presented in Section A.6.

Detailed site information with a map of the proposed monitoring stations is presented in Section A.6.

The Harmon Creek facility can be accessed off of US Highway 22 (US 22) by taking the Bavington Exit near mile marker 10. After the exit turn right onto Maple Grove Road then take the first left onto Steubenvile Pike. After approximately 0.9 miles, turn left onto Creek Road which turns into Point Pleasant Road. Continue on Point Pleasant Road for approximately 1.4 miles. A dirt road turn off will be on the right hand side which is the access road to the facility.

B.2 Monitoring Equipment and Methods Description

This section summarizes the air quality and meteorological equipment to be used at MarkWest's Harmon Creek monitoring stations. The proposed air toxic analyzers and meteorological sensors meet SPM monitoring requirements. The operating range of the sensors and monitors easily brackets the range of environmental conditions expected at the site. The equipment manufacturer and model numbers are outlined in Table B-1. The standard operating procedures followed to calibrate and operate the equipment listed in Table B-1 are presented in Table B-3.

Table B-1 Measurement Equipment to be Installed at the Harmon Creek Monitoring Stations

Parameter	Manufacturer/Model	Sensor Height (meters)
Air Toxics	Consolidated Analytical Systems (CAS) AirmOzone Auto-Gas Chromatographs (GCs)	4.0
Meteorological		
Wind Speed	RM Young Model 05305-5	10
Wind Direction	RM Young Model 05305-5	10
Temperature	Campbell Scientific EE181	2
Relative Humidity	Campbell Scientific EE181	2
Barometric Pressure	Vaisala PTB110	2
Data Storage	Campbell Scientific CR1000X	NA

At each of the three monitoring stations, there will be a data acquisition system installed inside the climate-controlled shelter to record and store the ambient fence line air toxic measurement data. At the Near Downwind Station, the data acquisition system will also collect the meteorological sensor data. Microprocessors in the analyzer will be protected by an uninterruptible power supply (UPS) system which will shield against electrical surges and short duration power outages. Lightning protection measures will be installed on the meteorological tower at the upwind station.

B.2.1 Air Toxic Monitoring Equipment Description

At the Harmon Creek facility, Consolidated Analytical Systems (CAS) AirmOzone Auto-Gas Chromatographs (GCs) will be used at the upwind and both downwind monitoring locations to provide continuous air toxic measurements. The rack-mounted CAS/Chromatotec AirmOzone system consists of an AirmoVOC C2-C6, GC/FID for light hydrocarbons and an AirmoVOC C6-C12, GC/FID for heavy hydrocarbons. A flame ionization detector (FID) allows for no interference from competing compounds. The gas sample is split between the two GCs, and the gas samples flowing to each of the two GCs are drawn through traps which extract the target gas components (C2-C6 or C6-C12) from the samples. To enhance adsorption of compounds with lower boiling points, the traps are cooled; the C2-C6 trap is set at -10 °C, and the C6-C12 trap is set at 20 to 25 °C. The concentrated analytes are then desorbed and routed to the two chromatographic columns for measurement.

The CAS/Chromatotec system uses hydrogen as the carrier gas. The FIDs use hydrogen and zero air as fuel gases. Both hydrogen and zero air are supplied by gas generators that are provided with this system. This system also includes a calibration gas generator, which allows for automatic data validation and sample conditioning.

The CAS/Chromatotec system comes standard with an embedded PC and software. The Vistachrom software allows the determination of concentrations, retention times and peak areas. This software incorporates several utilities to enable the user to interface with the analyzers, to configure the measurements, and to setup and control threshold alarms. This capability includes features such as

manipulating and reprocessing data, performing system checks, exporting data, and remotely.
The compounds detected by the Airmozone Auto-GC include C_2 to C_6, i.e., from ethane through 1,3-butadiene up to benzene and up to 32 compounds from C_6 to C_{12} (hexane, dimethylbutane, diethylbenzene, naphthalene, dodecane, BTEX, and halogen compounds). The detection range for C_2 to C_6 compounds is 0.033 to 500 µg/m³ of 1,3-butadiene with a lower detectable limit of 15 ppt (33 ng/m³) for 1,3-butadiene. For C_6-C_{12} compounds, the detection range is 0.05 to 400 µg/m³ for tri-methylbenzene with lower detectable limits of 10 ppt or 0.05 µg/m³ for tri-methylbenzene and 10 ppt for benzene.

Each auto-GC system will be housed in climate-controlled 8' X 8' X 8' monitoring shelters. The aluminum shelter features a heavy duty industrial HVAC heating and air conditioning system, instrument rack, cabinet, countertop, and exhaust sampling manifold. The shelter is equipped with a 100-amp electrical load center. Full specifications for the air toxic monitoring equipment can be found in Appendix A.

B.2.1.1 Air Toxic Inlet Probes

The inlet probe used for the air toxic analyzers is made of 1/4" Teflon tubing interfaced to a weather resistant shield and block assembly also comprised of Teflon. A five-micron Teflon in-line filter is built into the analyzers. This Teflon filter is changed monthly or as needed. The Teflon tubing inlet probe will be replaced annually or as needed.

The inlet probe will be placed between two and five meters above ground and have at least unrestricted airflow 270 degrees around the sample inlet. The inlets will be placed at least one meter away from any supporting structures or walls.

B.2.2 Meteorological Equipment Description

A brief description of each meteorological sensor to be installed at the Harmon Creek upwind monitoring station is discussed in this section. Full specifications for each piece of equipment can be found in Appendix A.

B.2.2.1 Wind Direction and Wind Speed

The R.M. Young Model 05305 Wind Monitor AQ is a high resolution wind sensor designed specifically for air quality applications and made of UV-stabilized plastic with stainless steel and anodized aluminum fittings. Precision grade, stainless steel ball bearings are used. Transient protection and cable terminations are in a convenient junction box. The wind speed sensor is a four blade helicoid propeller. Propeller rotation produces an AC sine wave voltage signal with frequency directly proportional to wind speed. Slip rings and brushes are eliminated for increased reliability. The starting threshold is 0.4 m/s.

The wind direction sensor is a rugged yet lightweight vane with a sufficiently low aspect ratio to assure good fidelity in fluctuating wind conditions. Vane angle is sensed by a precision potentiometer housed in a sealed chamber. With a known excitation voltage applied to the potentiometer, the output voltage is directly proportional to vane angle. A mounting orientation ring assures correct alignment of the wind direction reference when the instrument is removed for maintenance. The vane starting threshold is 0.5 m/s at 10 degrees displacement.

B.2.2.2 Temperature/Relative Humidity

The EE181 is a rugged, accurate air temperature and relative humidity (RH) probe that is ideal for long-term, unattended applications. It includes a proprietary coating on the RH element that increases the life of the element and protects it from dirt, dust, salt, or other contaminants. A 1000 Ω PRT measures air temperature for the -40° to +60°C range.

B.2.2.3 Barometric Pressure

The Vaisala Model PTB110 barometric pressure sensor has a digital accuracy of 0.3 hPa at 20°C and will measure barometric pressure over a 500 to 1100 hPa range.

B.2.2.4 Data Acquisition System

Campbell Scientific CR1000X DAS will be used to store data from the air toxic analyzers and meteorological sensors. The DAS uses one-second data values to compute and stores 5-minute averages of temperature, scalar wind speed, unit vector wind direction, sigma theta of wind direction, and barometric pressure. 10-minute air toxic data will be stored by the DAS at the each station. The DAS is capable of being polled locally through a USB, Ethernet, MicroSD, or RS-232 connector, or remotely via an internet connection.

B.2.2.5 10-Meter Aluminum Tower

The meteorological sensors will be secured to a 10-meter guyed aluminum tower. This lightweight tower can be lowered by walking it down servicing instrumentation. Lightning protection is mounted to the tower.

B.2.2.6 Telecommunications

A Sierra Wireless RV50 configured with a Verizon static IP will be used for high speed remote communication to the CR1000X data acquisition system. The RV50 has all of the firewall protection and routing protocols necessary for protection, isolation, and security. A 3db gain omni directional antenna will be installed on the tower.

Table B-2 presents the equipment specifications and the SPM criteria for the meteorological sensors.

Table B-2 Meteorological Equipment Specifications

Parameter	Specifications	EPA Criteria	Selected Site Sensor Specifications
Wind Speed	Starting Threshold	WS <0.5 m/s	WS = 0.22 m/s
	Accuracy	±0.25 m/s ≤5 m/s; 5% > 2 m/s not to exceed 2.5 m/s	±0.07 m/s (0.15 mph)
	Distance Constant	≤5 m	1.5m
Wind Direction	Starting Threshold	<0.5 m/s	0.22 m/s (0.5 mph)
	Damping Ratio	0.4 to 0.65	>0.4 at 10° of attack
	Delay Distance	<5 m	<1.0 m
	Accuracy	±5 degrees	±2 degrees
Temperature	Accuracy	≤1.0 °C	±0.1 °C
Relative Humidity	Accuracy	±10%RH	± (1.5 + 0.015 • RH reading) % RH from -40°C to 60°C
Barometric Pressure	Accuracy	±3 mb (±2.25 mmHg)	±0.2 hPa (25°C) 0.3 hPa (-40 to 60°C)

B.2.3 Standard Operating Procedures

Standard operating procedures have been developed for the site operators regarding routine operation of all site equipment. These SOP's range from inventory of equipment, equipment inspection and acceptance testing, visual inspections, preventive maintenance, and calibrations. Table B-3 presents the SOPs used for this program. Copies of these SOP's can be found in Appendices D-F.

Table B-3 Standard Operating Procedures

SOP No.	Revision No. and Date	SOP Title	Regulatory Citation
SOP 69	Rev 4. 09/18/2014	Calibration and Audit Equipment Certification	1,2
SOP 106	Rev 2. 09/18/2014	In-House Calibration of Test Equipment	1,2
SOP 107	Rev 2. 09/18/2014	Equipment Inventory Procedure	NA
SOP 113	Rev 2. 09/18/2014	Visual Inspection of Meteorological Equipment	1
SOP M11	Rev 6. 09/18/2014	Wind Direction Calibration	1
SOP M12	Rev 4. 09/18/2014	Wind Speed Calibration	1
SOP M13	Rev 4. 09/18/2014	Temperature	1
SOP M15	Rev 4. 09/18/2014	Relative Humidity Calibration Procedures	1
SOP M17	Rev 3. 09/18/2014	Barometric Pressure Calibration	1
SOP 166	Rev 0. 06/15/2018	AIRMOVOC C_2-C_6 Startup and Stop Procedure	3
SOP 167	Rev 0. 06/15/2018	AIRMOVOC C_6-C_{12} Startup and Stop Procedure	3
SOP 168	Rev 0. 06/15/2018	AIRMOVOC C_6-C_{12} Calibration with Ext. Standard	3
SOP 168	Rev 0. 06/15/2018	AIRMOVOC C_6-C_{12} Permeation Tube Replacement	3

[1] Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements Version 2.0 (Final).
[2] Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II: Ambient Air Quality Monitoring Program.
[3] Manufacturer Specifications

Routine maintenance will be performed on the air toxic monitoring equipment to ensure that the monitoring equipment is operating properly and data are accurate. The type and frequency of the maintenance to be performed will be in accordance with manufacturer recommendations. Spare parts will be retained and stored in a secure area at the monitoring shelters. A list of maintenance activities to be performed is presented in Table B-9.

Conditions adverse to quality will be identified promptly by the Data Manager or site technician and the Project Director will be notified. Once an issue that is adverse to quality has been identified by the Data Manager, the Project Director or his designate will troubleshoot the issue to identify the cause and the issue will be corrected as soon as possible. The Project Director will initiate a Corrective Action Report form (Appendix B) which includes the date and time when the problem was identified, the proposed corrective action to resolve the issue, and the date and time of the results of the proposed action.

B.3 Sample Handling and Custody

There are no discrete samples handled by individuals using the AutoGC's for air toxic determination. The air toxic samples will be collected through ¼ inch Teflon tubing. The sample gas cannot contain liquids or particulates. If the sample gas contains fine particulates, they will be removed with a Teflon filter.

B.4 Analytical Methods

As described in Section B.2, the sampling and analytical methods to determine ambient air toxic will be performed using a high performance gas chromatograph with flame ionization detection (FID) and an on-line sample preparation. The proposed instrument is designed for the analysis of speciated VOC's, specifically C_2-C_6 and C_6-C_{12} in gaseous samples. SOPs for this equipment are presented in Appendices D and E.

B.5 Quality Control Requirements

This section describes the routine quality control procedures used for the Harmon Creek air toxics and meteorological monitoring program. All procedures have been specifically designed to provide the appropriate quality control and ensure that valid data recovery meets or exceeds the 75% data completeness requirement per quarter for air toxic and meteorological parameters.

The air toxics monitoring will follow the quality control guidelines as stated in the following documents:

- Technical Assistance Document for the National Air Toxics Trends Stations Program, Revision 3, and
- EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, January 2017.

The QC basics performed on the continuous GC system are:

- Daily internal calibration check
- Weekly precision of results for internal standards
- Weekly head column pressure
- Weekly retention time verification
- Weekly signal amplification
- Weekly blank (NMTHC)
- Weekly operating temperature check

The meteorological monitoring program will follow the quality control guidelines as stated in the following documents:

- *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV*: Meteorological Measurements, March 2008; and
- *Meteorological Monitoring Guidance for Regulatory Modeling Applications*, 2000.

The QC activities on the meteorological equipment include visual inspection of instrumentation integrity, measurement consistency with current conditions, annual calibrations, and corrective actions.

Table B-4 presents quality control procedures and frequency.

Table B-4 Quality Control Procedures

Procedure	Frequency	Requirement
1. Visual Inspection of Equipment	Routine or Emergency Site Visits; Weekly or more frequent by the site operator	Meets MQO (Tables A-7 and A-9)
2. Remote interrogation of monitoring station and inspection of data	Daily	QC Checks for data screening (Section B.10)
3. Routine calibration verification	Meteorological - semi-annually Air toxics - Daily	Meets MQO
4. Calibration reference standard certification	Annually - meteorology Calibration of gases every two years	NIST-traceable or A2LA if applicable
5. Precision checks	Weekly	Meets MQO
6. Equipment Maintenance	Annually or as needed	Section B.4
7. Personnel Training	On-going	MSI Trinity SOP 109
8. Operating Temperature	Weekly	15°C to 30°C ±3°C
9. Data validation	Daily and monthly	Electronic data screening Time/Parameter Plot visual check

	Quarterly	Data processing calculation check Missing data confirmed Off-line periods confirmed Data validation checklist

B.5.1 Visual Inspection of Equipment

The site technician will visit the climate-controlled shelters at least once each week to check that the air toxic analyzers are operational and recording concentrations typical for the environment. At this time, the site technician will inspect the shelter temperature and adjust the thermostat, if necessary. Any maintenance will be performed during this time, as needed. Visual inspection of the meteorological tower will also occur during the site visit. The site visits and worked performed will be recorded in the E-logbook for each station.

B.5.2 Remote Interrogation of Monitoring Station and Inspection of Data

Each DAS at the Harmon Creek air toxic monitoring stations will be interrogated daily via internet connection to download and process the data. Computerized inspection and visual inspection of these data will be performed daily using an outlier program. Values that fall outside of prescribed limits (Tables B-5 through B-8) will be evaluated by a qualified air quality specialist and corrections to data will be documented. Abnormal data values or problems will be reported as soon as possible to the Program Director who will initiate corrective action and determine if a special site visit is required. MarkWest personnel will be notified of spikes in data.

B.5.3 Equipment Calibration

In addition to the automated, daily calibrations, the air toxics monitoring equipment will be manually calibrated quarterly, when changes are made to the analyzer, or when problems require it.

Meteorological equipment calibrations will be performed when problems are noted and semi-annually. Sensors which do not meet calibration specifications or fail performance audits will be repaired and recalibrated.

See Section B.7 for calibration procedures.

B.5.4 Calibration Reference Standard Certification

Calibration reference gases are certified as required to maintain EPA tolerances. Reference standards used for calibration of meteorological sensors will be certified annually and will be traceable to National Institute of Standards and Technology (NIST) standards. Calibration certificates are on file at MSI Trinity's office and are included with each calibration report. Reference standards will be certified over the ambient measurement range expected at the Harmon Creek monitoring stations.

B.5.5 Flow Calibrations

Flow calibrations will be conducted annually. The flow calibration will be conducted by performing a direct volumetric measurement of the gas flow with a calibrated reference gas flow meter at several different flow rates. Agreement between the measured flow rates and the NIST-traceable flow standard values should be within ±2%; otherwise, the site technician will notify the Project Director and the affected data will be flagged.

B.5.6 Equipment Maintenance

Manufacturer's recommendations for maintenance of the air toxic analyzers and meteorological sensors will be followed. Instrument instruction manuals are available at the site for reference of troubleshooting, and preventive and remedial maintenance procedures. Preventive and corrective maintenance will be documented in the E-logbook immediately after any maintenance. See Section B.6.3 for equipment maintenance procedures.

B.5.7 Personnel Training

Personnel operating the air toxics and meteorological monitoring stations will be thoroughly trained in the proper operation, calibration, and maintenance of the equipment to ensure continued collection of valid, representative data.

B.5.8 Temperature-Controlled Monitoring Shelter

The shelter's role in quality control is to provide a temperature-controlled environment in which the air toxic monitoring equipment can operate at optimum performance. The mean shelter temperature should be approximately 20°C. Shelter interior temperature, measured with a calibrated resistance temperature detector (RTD), will be continuously monitored and recorded by the datalogger and reported along with other measurements. Daily shelter fluctuation ≤±2°C standard deviation over 24 hours may indicate a need to adjust the temperature control system.

B.5.9 Data Validation

Table B-5 outlines the criteria deemed critical for the air toxic measurements. Data that do not meet each and every criterion on the critical table should be invalidated unless compelling reason or justification exists for not doing so. The samples for which one or more of these criteria are not met are invalid unless proven otherwise. The cause for not operating within the acceptable range for each violated criteria will be investigated and corrective action taken to remedy the problem such that additional data will be invalidated. The Project Director will be alerted by the Data Manager or site technician when critical criteria are exceeded. Project Director will notify MarkWest when critical criteria are exceeded causing data to be invalidated.

Tables B-6 and B-7 present the criteria that are important for maintaining and evaluating the quality of the data collection system. Violation of a criterion or a number of criteria may be cause to invalidate data. The decision to invalidate should consider other control information that may or may not indicate that

these data are acceptable. The data for which one or more of these criteria are not met is suspect unless other quality control information demonstrates otherwise. The Project Manager will be alerted by the Data Manager or site technician when the operation criteria are not being met and the issue will be investigated, mitigated, or justified.

Tables B-8 and B-9 presents systematic issues that are important for the correct interpretation of the data. These issues, however, usually do not impact the validity of the data. See Section D of this QAPP has specifics on the data validation procedures.

Table B-5 Critical Criteria for Air Toxic Measurements

Requirement	Frequency	Acceptance Criteria	Reference	Action
Internal Cal. Check	Daily	≤10%	Manuf. recommendation	Recalibrate
Precision of results for internal standards	Weekly	≤15%	Manuf. recommendation	Recalibrate

Table B-6 Operational Criteria for Air Toxic Measurements

Requirement	Frequency	Acceptance Criteria	Reference	Action
Operating temperature	Weekly	15°C to 30°C	Manufacturer Specifications	Flag data for which temperature range are outside acceptance criteria
Head Column Pressure	Weekly	±5 hPa	Manufacturer Specifications	Adjust/remove leak or restriction
Retention time	Weekly	All compounds within their respective retention windows	Manufacturer Specifications	Re-define window
Signal amplification	Weekly	Peak areas between minimum area and saturation limit of signal	Manufacturer Specifications	Adjust chromatec software parameters
Blank (NMTHC)	Weekly	≤10ng	Manufacturer Specifications	Re-zero. Perform column conditioning

Table B-7 Systematic Criteria Air Toxic Measurements

Requirement	Frequency	Acceptance Criteria	Reference	Action
Siting	1/year	Meets siting criteria	40 CFR Part 58 App. E	---
Performance audit	Every site 1/year within period of monitor operation	Meets audit criteria	EPA recommend	---

Verification/ Calibration	Upon installation and annually	Meets calibration criteria	EPA recommend	---
Base Sensitivity	Every 6 months	3000-4000 area units/ng	Manufacturer recommended	---
Sample Flow	Every 6 months	±2 cc/min	Manufacturer recommended	---
Zero and hydrogen air flow to FID	Every 6 months	±5%	Manufacturer recommended	---

B.6 Instrument/Equipment Testing, Inspection and Maintenance

B.6.1 Acceptance Testing of Instrumentation and Equipment Integration

Prior to installation, all equipment will be visually inspected to ensure there is no physical damage. Acceptance testing of instrumentation will be performed to verify that the instruments meet the required US EPA performance specifications. Analyzers and sensors that fail to meet specifications will be returned to the manufacturer. After installation, the air toxic analyzers and meteorological sensors are calibrated according to the procedures presented in each respective operating manual. To ensure that the monitoring equipment continues to operate properly, checks of the instruments will be conducted at a minimum, quarterly. Preventive maintenance and quality assurance procedures will be conducted on a routine basis.

Acceptance testing procedures will be documented on the appropriate calibration forms. To ensure that the sensors and analyzers are operating properly, periodic performance audits are conducted by an outside contractor.

B.6.2 Site Surveillance and System Check Procedures

At least monthly or as needed, the site technician will visit the monitoring station to inspect the monitoring shelter, meteorological tower and sensors, and air quality equipment. The primary site operator will conduct any maintenance that is required. The site technician will also verify proper operation of the data acquisition system, analyzer, and zero air and hydrogen generators. During each site visit, entries will be made in the site E-logbook documenting all site activities conducted. These entries will include the date of the visit, reason for the visit, and the maintenance or calibration activities performed. If changes are made to the equipment or configuration of the system, these changes will also be entered in the site logbook. Entries will be made any time there is a change or modification in the way a sample is obtained, or the station configuration altered. If the site operator encounters a problem which cannot be rectified, he/she will contact the Project Director who will be responsible for resolving the issue. The Project Director will initiate a plan for corrective action and will employ whatever resources are required to rectify the situation.

Entries will be made when: (1) new fittings or other components are added or removed in any stream of sample air to the analyzers, (2) the relative position of the analyzers' sample ports on the manifold or tubing is changed, (3) a new pump in an analyzer is replaced, (4) the location of a sampling inlet or port

is moved, or (5) any similar change in the air monitoring station's configuration.

Personnel operating the air toxics and meteorological monitoring program are thoroughly trained in the proper operation and maintenance of the equipment to ensure continued collection of valid, representative data.

B.6.3 Site and Equipment Maintenance

Manufacturer's recommendations for maintenance of the air toxic analyzers and meteorological sensors will be followed. Instrument instruction manuals are available for reference of preventative and remedial maintenance procedures. Preventive and corrective maintenance will be documented on the calibration forms completed immediately after any maintenance.

The maintenance activities that will be performed at Harmon Creek monitoring sites are presented in Table B-8. Table B-9 presents the analyzer maintenance and frequency that the maintenance is performed.

Table B-8 Site Maintenance Activities

Maintenance Activity	Frequency
Sample intake manifold cleaning	Monthly or as needed
Sample inlet tubing replacement	Annually or as needed
Monitoring shelter floor cleaning	Monthly or as needed
Heating/AC system filter replacement	As needed
Monitoring shelter light bulb replacement	As needed

Table B-9 Equipment Maintenance Activities

Maintenance Activity	Frequency
CAS AIRMOVOC Analyzers	
Refill of deionized water in H_2 generator	monthly
Valve rotor and o-ring replacement	annually
Permeation Tube standards	annually
Cleaning	annually
Calibration Check	annually
Meteorological Sensors	
Wind Speed Bearings Replacement	Biannually or as needed
Wind Direction Bearings Replacement	Biannually or as needed
Wind Direction Potentiometer Replacement	As Needed
Carbon Fiber Propeller Replacement	As Needed

Particulate Filter & Cap Cleaning or Replacement	As Needed

B.6.4 Spare Parts

Spare parts for the air toxic analyzers will be stored in the monitoring shelter and will be used as needed. These spare parts include, but are not limited to deionized water and various o-rings.

B.7 Instrument/Equipment Calibration and Frequency

B.7.1 Air Toxic Analyzer

An internal calibration enables adjustment to the base sensitivity of the instrument which will be used to calculate the concentration of each compound. Calibration standards are permeation tubes calibrated and certified (±10%), and installed into the temperature controlled oven of the airmoCAL. Permeation values are selected in the range of instruments using FID.

Instrument manuals will be available at the monitoring sites and digitally. The procedure to perform an external calibration is provided in SOP 168. The calibration procedures for the air toxic analyzer is presented in Appendix C.

B.7.2 Meteorological Calibration Procedures

Meteorological equipment calibrations will be performed semi-annually with equipment that is in current calibration and is traceable to National Institute of Standards and Technology (NIST) or A2LA standards. Sensors which do not meet calibration specifications or fail performance audits will be repaired and re-calibrated. Calibration certifications and records will remain on file at MSI Trinity.

Calibration procedures for the meteorological sensors are presented below. Standard Operating Procedures for meteorological sensor calibration are provided in Appendix C.

B.7.2.1 Wind Direction

The cross arm orientation will be checked using a professional compass. The wind vane will be aligned with the cross arm and set to true north. True north is distinguished from magnetic north by reading a magnetic compass and applying a correction factor for the magnetic declination. The declination will be determined from a declination calculation computer program. If the overall wind direction error (orientation plus linearity) exceeds ±5 degrees from true North, the sensor will be re-calibrated.

The wind direction sensor starting threshold will be checked using a torque gauge. The torque gauge is placed on the sensor shaft and the torque is measured. If the sensor starting threshold is greater than 0.5 meters per second (m/s), the bearings will be replaced and the sensor will be re-calibrated.

The wind direction linearity will be checked using a direction template. The sensor response will be checked at a minimum at 30 degree increments in both clockwise and counterclockwise rotations and compared with the DAS readings. If the indicated wind direction linearity plus orientation error exceeds ±5 degrees, the sensor will be repaired and re-calibrated.

B.7.2.2 Wind Speed

Horizontal wind speed response checks will be performed using a synchronous motor. Sensor readings taken from the DAS will be compared to calibration values obtained from transfer functions provided in the sensor manufacturer's specifications. If the wind speed error exceeds ±0.2 m/s when ≤5 m/s or ±5% when > 5 m/s not to exceed ±2.5 m/s, then the instrument will be recalibrated.

The horizontal wind speed sensor starting threshold will be checked using a torque gauge or a torque disc. The torque device is placed on the sensor shaft and the torque is measured. If the measured torque exceeds manufacturer's tolerance specifications for wind speed sensor starting threshold of 0.5 m/s, then the bearings will be replaced and the instrument will be recalibrated.

B.7.2.3 Temperature

Temperature sensor calibration will be verified by direct comparison of sensor outputs to a collocated calibrated reference standard thermometer encompassing the measurement range expected at that particular site. If the sensor output is more than 1.0 degrees Centigrade (ºC) different from the reference, the sensor will be repaired and re-calibrated. Sensors at different levels will be checked simultaneously in the same medium so that the delta temperature (ΔT) function can be verified. If the vertical temperature difference differs by more than 0.1°C for 2-10 meter, the sensors will be repaired/replaced and re-calibrated.

B.7.2.4 Relative Humidity

The relative humidity sensor calibration will be verified by comparison of station sensor outputs with a relative humidity reference sensor collocated at ambient conditions. If the site sensor output differs by more than ±10 percent relative humidity from the reference, the sensor will be recalibrated.

B.7.2.5 Barometric Pressure

The barometric pressure sensor calibration will be verified by collocation of a certified reference barometer and comparing the reference output with sensor outputs recorded on the data acquisition system. If the site sensor output differs from the reference by more than ±3 mb, the sensor will be re-calibrated.

The equipment used to perform meteorological sensor calibrations is listed in Table B-10.

Table B-10 Meteorological Calibration Equipment

Parameter	Manufacturer	Model/Serial Number
Wind Direction	Brunton RM Young RM Young	Pocket Transit Model 5008 Model 18331 Vane Torque Gauge Model 18215 Vane Angle Fixture
Wind Speed	RM Young RM Young	Model 18811 Anemometer Drive Model 18310/18311 Torque Disc
Temperature	Brooklyn	Model 6661 Thermometer
Relative Humidity	Vaisala	HMP45C Digital Humidity Sensor
Barometric Pressure	Vaisala	Digital Barometer

B.7.3 Calibration Forms

Meteorological sensor and air toxics calibration forms are included in Appendices D and E.

B.7.4 Calibration Frequency

The air toxic analyzers come with factory calibrations, and are verified upon installation. The permeation tubes are verified or replaced annually. Daily internal calibration checks will indicate the accuracy of the instrument. Meteorological instrument calibrations will be performed at installation once sensors are interfaced with the data acquisition system, semi-annually, and whenever an instrument exceeds specified control limits or undergoes major maintenance or repair. If a sensor fails a performance audit, calibration verification will be documented and then it will be replaced or repaired and re-calibrated. If possible, an as found calibration checks will be documented and then an after maintenance calibration check will follow.

B.8 Inspection/Acceptance of Supplies and Consumables

Spare parts will be purchased only from the instrumentation manufacturer by the Project Director. They will be inspected by the Project Director or site technician for shipping damage upon receipt. Spare parts will be kept in the monitoring shelter for use when needed. The use of spare parts will be documented on calibration forms.

B.9 Non-direct Measurements

All data collected for this project will be direct measurement. The site location will be verified with a GPS.

B.10 Data Management

Continuously sampled data will be managed within MSI Trinity's computer system. The proper management of all data is critical to assuring the quality and usability of the monitoring results. As such, procedures have been implemented to ensure robust data acquisition, validation, reduction, reporting, and storage of electronic data. Air toxic and meteorological monitoring data will be recorded and stored

on site using the CSI CR1000X data loggers. These data will be retrieved from the monitoring site daily via secure IP connectivity.

All electronic calculations and statistical analyses will be performed using standard software (Microsoft Excel) that can be easily verified. All project documentation, records, data, and reports will be stored for at least five years following project completion. The data are stored on a personal computer at MSI Trinity which is backed up to network storage nightly and will be archived at two separate locations.

Air toxic and meteorological data will be reviewed routinely by the Data Manager and by the project meteorologist or air quality specialist assigned to this project. These data will be subjected to several levels of quality control, validation and quality assurance as discussed in Section D. Validated data are compiled into the final database for further analysis and report preparation. The final database is processed, stored, and archived on various storage media and redundant copies maintained in several diverse locations for protection.

The Data Manager will archive data on MSI Trinity's network and on storage hard drives which are stored off-site. The overall flow of data management is illustrated in Figure B.1.

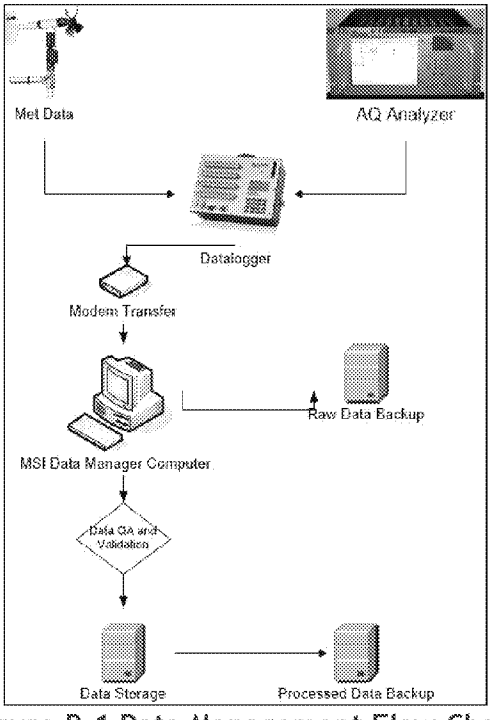


Figure B.1 Data Management Flow Chart

The air toxic and meteorological will be summarized in monthly tables and reported quarterly. The quarterly reports will conform to EPA guidance.

B.10.1 Data Retrieval

Data is retrieved from the site by connecting to the DAS via remote telemetry.

B.10.2 Raw Data

Raw data are records, notes, memoranda, worksheets or exact copies and are the result of original observations and activities of the monitoring project. Raw data include data from the DAS and data entered directly into a system.

B.10.3 Data Transfer

The analyzer and sensors produce digital and analog voltages that are collected by a DAS and averaged for a particular time period. The data are stored on a network and are validated quarterly.

B.10.4 DAS Data Review

Data review is performed by an air quality specialist or meteorologist. The review of the data includes reviewing the daily calibration information, maintenance logs, hourly data, flags, and recording any information that might be vital to proper review of the data. Information used in the review and which may be used to invalidate data are input to Excel spreadsheets. An Excel database will be used to compile the VOC and meteorological data.

A data report QA checklist is also used which is presented in Appendix D. This list provides a reminder for the reviewing meteorologist or air quality specialist to verify missing data periods, percent data recovery, data table calculations, to name a few. Data review also includes documentation of suspect data or invalidations that occurred.

B.10.5 Data Validation

Data validation ensures that data processing operations have been carried out correctly and that the quality of field operations has been performed properly and in accordance with written procedures. Once data validation has identified problems, the data can be corrected, flagged or invalidated and correction actions can be taken when necessary. In the event of a failed audit or out of range calibration, the air quality specialist or meteorologist will be responsible for checking or invalidating data. Data validation procedures are described in detail in Section D.

B.10.6 Data Transmittal

Data transmittal occurs when data are transferred from one location to another or from one person or group to another. An example of data transfer is the electronic transfer of data over a telephone or computer network. The Data Manager will report all air toxic data and information as specified by EPA. Such data will be fully validated and will be submitted directly to EPA and MarkWest via electronic transmission.

B.10.7 Data Processing

Data processing includes the aggregating and summarizing of results so they can be easily understood and interpreted in various ways. EPA regulations require certain summary data be computed and reported on a regular basis such as precision, accuracy, bias, etc.

B.10.8 Data Analyses

Data summary and analysis requirements, as presented in 40 CFR Part 58, Appendix A will be followed for this program. Single analyzer accuracy, based on performance audits, single analyzer precision, bias, and data completeness will be tracked and reported for the monitoring network.

B.10.9 Data Flagging

Data will be flagged if a numeric result was available but it has been qualified in some respect related to the validity of the result.

An exceptional event, as defined in 40 CFR §50.1 (j) provides that an exceptional event is one that affects air quality, is not reasonably controllable or preventable, and is caused by human activity that is unlikely to recur at a particular location or a natural event. Additional requirements in 40 CFR §50.14(1)(2) and (b)(1) identify that a state must demonstrate a "clean and casual relationship between the measured exceedance or violation of such standard and the event" and that "an exceptional event caused a specific air pollution concentration in excess of one or more national ambient air quality standards." Thus, MSI Trinity will flag data related to an exceptional event at the request of the MarkWest.

B.10.10 Data Storage and Retrieval

Electronic copies of the data will be stored at MSI Trinity.

C ASSESSMENTS AND OVERSIGHT

Review of project performance is done on a continuous basis. This section addresses the assessment and response actions.

C.1 Assessments and Response Actions

An independent auditor will perform the annual performance audits on the air toxic and meteorological monitoring equipment. Audit procedures and techniques to be followed are established EPA audit guidelines. The performance audits will be attended by MSI Trinity personnel. At the conclusion of each audit, MarkWest and MSI Trinity will be aware of the results.

C.1.1 Data Quality Audits

Data review is conducted daily utilizing electronic and visual scanning to identify outliers and determine whether data are reasonable and representative. The systems audit includes a confirmation of the integrity of transmitted data from sensor outputs to data reporting.

C.1.2 Corrective Actions

All deficiencies identified during routine data surveillance, performance audits and/or site surveillances will be documented and reported to the Project Director no later than one working day of discovery and, depending on the nature of the deficiency, corrective action will be made no later than seven working days of the notification. Corrective actions to deficiencies will be addressed and documented in the station logbook and on a Corrective Action Report. Follow-up action shall be taken to verify implementation of the corrective action. A corrective action report form will be filled out that identified the problem or deficiency, the proposed corrective action, and the results of the corrective action. A copy of a Corrective Action Report is presented in Appendix B.

C.1.3 QAPP Revisions

If revisions to the MarkWest QMP/QAPP are needed, any modifications will be approved by the MarkWest and submitted to EPA Region 3 for review and comment, and a revised edition will be distributed to all appropriate individuals on the distribution list. QAPP reviews will be performed annually by MSI Trinity for any updates.

C.2 Reports to Management

A summary of the reports to be generated is presented in Table C-1. The quality assurance director or her designate will generate reports to management.

Table C-1 Reports to Management

Reports	Frequency	Content	Responsible Position/ Individual	Distribution
Quarterly Summaries (Includes Precision and Accuracy)	Quarterly	Summarize Data for Quarterly Summaries	MSI Trinity Data Manager Brian Olsen or Wyndam Lewis	See Section A.3 Distribution List
Corrective Action Reports	As Needed	Summarizes Corrective Actions Taken to return the Monitoring Station into compliant status	MSI Trinity Project Director Casey Lenhart	See Section A.3 Distribution List
Response to Corrective Action Reports	As Needed	Reports the results of the Corrective Actions Taken	MSI Trinity Project Director Casey Lenhart	See Section A.3 Distribution List

Quarterly summaries will be submitted to MarkWest within 60 days of the end of the monitoring quarter. Corrective action reports are submitted as needed within one week of identifying a deficiency.

D DATA VALIDATION AND USABILITY

D.1 Data Review, Validation, and Verification Requirements

The air toxic data validation criteria are based on US EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I and II and* EPA's suggested air toxic data validation templates. Data that do not meet the criterion outlined in this QMP/QAPP should be invalidated unless there is a compelling justification for not doing so.

Meteorological data validation criteria are based on the US EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV (March 2008)*, and US EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications (February 2000)*, including recommended system accuracies and response characteristics for meteorological sensors and other applicable US EPA guidance.

The Project Director and site technicians are responsible for verifying proper operation of the air toxics and meteorological monitoring equipment. The Data Manager and Project Director will review the incoming data to the standards discussed in Section B.5 of this document. During each quarter, the data will be reviewed again by a qualified meteorologist appointed by the QA Manager to ensure that the data are complete, accurate, and representative and that erroneous data have been removed in preparation for the final data report.

The Data Manager will routinely check for irregularities during the daily data review. Data review includes evaluation of the raw data, daily internal calibration information, flow data, maintenance records, calibration and audit data. Any abnormalities in the data will be flagged and noted on the appropriate checklists. Any suspect data will be brought to the attention of the Project Director as soon as possible. All other documentation pertaining to the project (i.e. station logs, field notes, calibration and audit sheets) will be reviewed to insure that erroneous data are identified and removed, as necessary from the final data set.

Calibration procedures for the continuous air toxic analyzers and meteorological equipment are presented in Section B.7 of this QAPP. For both the air toxic and meteorological data, data will be considered valid when the system response indicated precision, bias and accuracy goals are being achieved.

D.1.1 Data Acceptance Limits for Air Toxic and Meteorological Parameters Based on Audits

In accordance with data acceptance criteria established by the EPA, data will be acceptable if quality assurance performance audits show the following results for accuracy:

- Air toxic sampler flow rate does not exceed ±10% of target flow;
- Daily internal calibration does not exceed ±15%;
- Weekly precision of results for internal standards do not exceed ±20%.
- The wind direction error (orientation plus linearity) does not exceed ±5 degrees from true north, and the sensor starting threshold is less than 0.50 m/s wind speed;

- The horizontal wind speed average absolute error does not exceed ±0.20 m/s. The sensor starting threshold must be less than 0.50 m/s wind speed for horizontal wind speed;
- The ambient absolute temperature sensor average absolute error does not exceed ±1.0°C;
- The barometric pressure sensor average absolute error does not exceed the acceptable tolerance of ±3 mb; and
- Relative humidity sensor absolute average percent difference does not exceed the acceptable tolerance of ±10% relative humidity.

The sampling frequency will be one second for all meteorological parameters.

D.1.2 Level 0 Data Validation

Level 0 data validation is essentially raw data obtained directly from the data acquisition systems in the field. These data have not received any adjustments for known biases or problems that may have been identified during preventive maintenance checks or audits. Level 0 data validation is accomplished by:

- Collecting data via modem, and
- Initially screening the daily data for anomalies using MSI Trinity's QC software (Section D.2.2).

Stacked parameter plots will be generated which consist of every data point downloaded since the last site interrogation and reviewed by a qualified meteorologist or air monitoring specialist for consistency and possible problems. This redundancy assures that problems that might go unnoticed by the software will always be caught by the reviewer.

To aid in data validation, a password-protected project web-site will be hosted which will be updated daily. The site contains 24-hour air toxic and meteorological chart graphics, daily minimum, maximums, and averages, quality assurance reports and wind roses. Historical data can also be reviewed at this web-site. Figures D.1 and D.2 presents examples of these graphics. By using this approach, data collection percentages are greatly enhanced and data management personnel can quickly note and resolve any potential instrumentation problems.

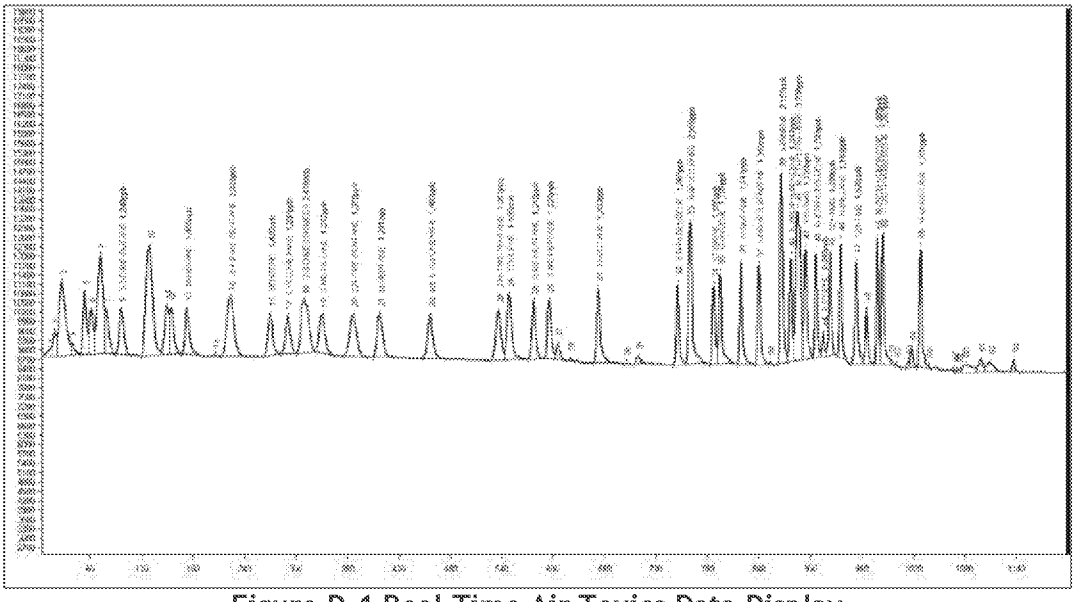


Figure D.1 Real-Time Air Toxics Data Display

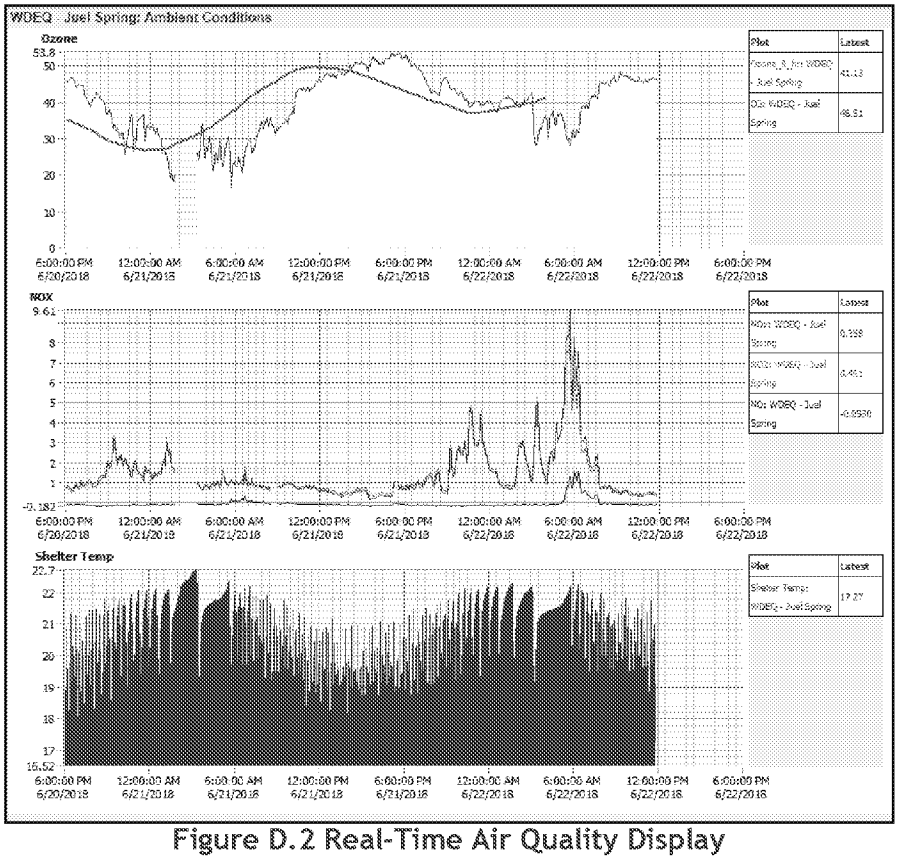


Figure D.2 Real-Time Air Quality Display

D.1.3 Quality Control Checks for Data Validation

Once data are downloaded via modem, they will be subjected to a series of quality control checks by a software package. The software package performs extensive quality control checks of the data, generates a data summary report which lists means, maximums, minimums, time of occurrence, data values which fall outside of prescribed ranges, periods of constant values, and periods of rapid value changes. This software uses selected data flagging criteria. Example criteria that will cause a data flag in the meteorological data include:

- Wind speed >25 m/s for a 5-minute average;
- Temperature change exceeds 4°C in a 5-minute period;
- Time increments greater than 5 minutes between data records;
- Ambient temperature exceeds 35°C;
- Ambient temperature falls below -30°C;
- Wind direction unchanged for 1 or more hours;
- Horizontal wind speed unchanged for 1 or more hours;
- Temperature unchanged for 1 or more hours;
- Battery voltage <11 volts;
- Change in pressure more than 1 mb in 5 minutes;
- Pressure is >795 mb;
- Pressure is <765 mb;
- Relative humidity >100%; and
- Relative humidity <5%.

These criteria may be adjusted as data are collected to more accurately encompass site-specific conditions.

For the air quality parameters, data review will consist of the following:

- Time increments greater than 10 minutes between data records;
- Large "jumps" or "dips" in concentrations;
- Benzene concentration < 45 ppt;
- Air toxic concentrations less than 0 ppb;
- Operating temperature <15°C; and
- Operating temperature >30°C.

The quality assurance software is used to generate flags or warnings that the parameter value is outside of a normally acceptable range. The outlier program does not invalidate data or erase file records on the basis of these outlier tests. Raw data files are never modified and are archived. It will be left to a qualified meteorologist to review the results of the outlier program in conjunction with the data parameter plots and initiate corrective actions if warranted (site visit or data invalidation).

D.1.4 Level 1 Data Validation

After the QC software is run, visual inspection of the data are performed to identify suspect data values that warrant further investigation. These values will be flagged.

Per EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, EPA recommends the use of flags or result qualifiers to identify potential problems with data (or a sample). According to EPA, a flag is an indicator of the fact and the reason that a data value (a) did not produce a numeric result, (b) produced a numeric result but it is qualified in some respect relating to the type or validity of the result, or (c) produced a numeric result but for administrative reasons is not to be reported outside the organization.

Thus, quality control flags and codes, consisting of a letter and value will be assigned to each datum to indicate its quality. Multiple flags will be applied to each invalid data point such as data invalid due to calibration. Table D-1 presents the data flags and codes that will be applied to the data.

Table D-1 Data Flags

Flag	Code	Description
V	0	Valid
C	1	Corrected or Estimated
S	7	Suspect: data appears to be a data spike or outside normal data range
I	8	Invalid data
M	9999	Missing data: measurement not taken
BJ	9963	Operator Error
AC	9969	Construction in Area
AE	9971	Shelter Temperature Outside Limits
AH	9974	Sample Flow Rate Out of Limits
AL	9978	Voided by Operator
AM	9979	Miscellaneous Void
AN	9980	Instrument Malfunction
AP	9982	Vandalism
AQ	9983	Collection Failure
AS	9985	Poor QA Results
AT	9986	Calibration
AV	9988	Power Failure
AW	9989	Wildlife Damage
AX	9990	Precision Check
AZ	9992	QC Audit
BA	9993	Maintenance
BB	9994	Unable to Reach Site
BC	9995	Multi-Point Calibration
BD	9996	Auto Calibration

To assist in data validation, a copy of the site and E-logbook will be examined to confirm periods when instrumentation may have been off-line due to power outages, maintenance or repair, audits, or other quality assurance activities. Significant events will be checked against the graphs for consistency.

Calibration data will be reviewed to assess the precision of the data. If the calibrations indicate invalid or low precision, data values may be invalidated or adjusted as necessary and the appropriate flags will be applied. The results from the remote zero/one point QC/span checks will also be reviewed to determine if the air quality data should be considered invalid. Especially high values will be checked to be sure that audit or calibration data were not inadvertently included. Suspect data will be reported but flagged as suspect. Missing data will be left missing.

It is important to maintain detailed, accurate records of changes to the data. The justification for all data invalidations will be permanently documented in a data validation summary spreadsheet. Suspect data will also be documented on a Quality Assurance/Data Validation Log (Appendix D).

For reporting purposes, hourly air toxic data will be presented. For the air toxics, pollutant data between 0 and -10 ppb are set to 0. The means, maxima and minima for the month will also be computed.

D.1.5 Minimum Acceptable Data Recovery Percentage

To be considered valid, each hour of air toxic data must consist of at least 40 minutes of valid data. The data recovery goal for the air toxics will be at least 85 percent per quarter. To be considered valid, each hour of meteorological data must consist of at least 45 minutes of valid data. Data recovery for meteorological parameters will be 90 percent per quarter.

D.1.6 Data Report QA Checklist

As part of the data validation process to prepare data for reports, report table content versus data files, missing data, off-line periods, percent data recovery and mathematical calculations are routinely verified. Cross-checks are documented on the Data Report QA Checklist presented in Appendix D.

D.2 Reconciliation with User Requirements

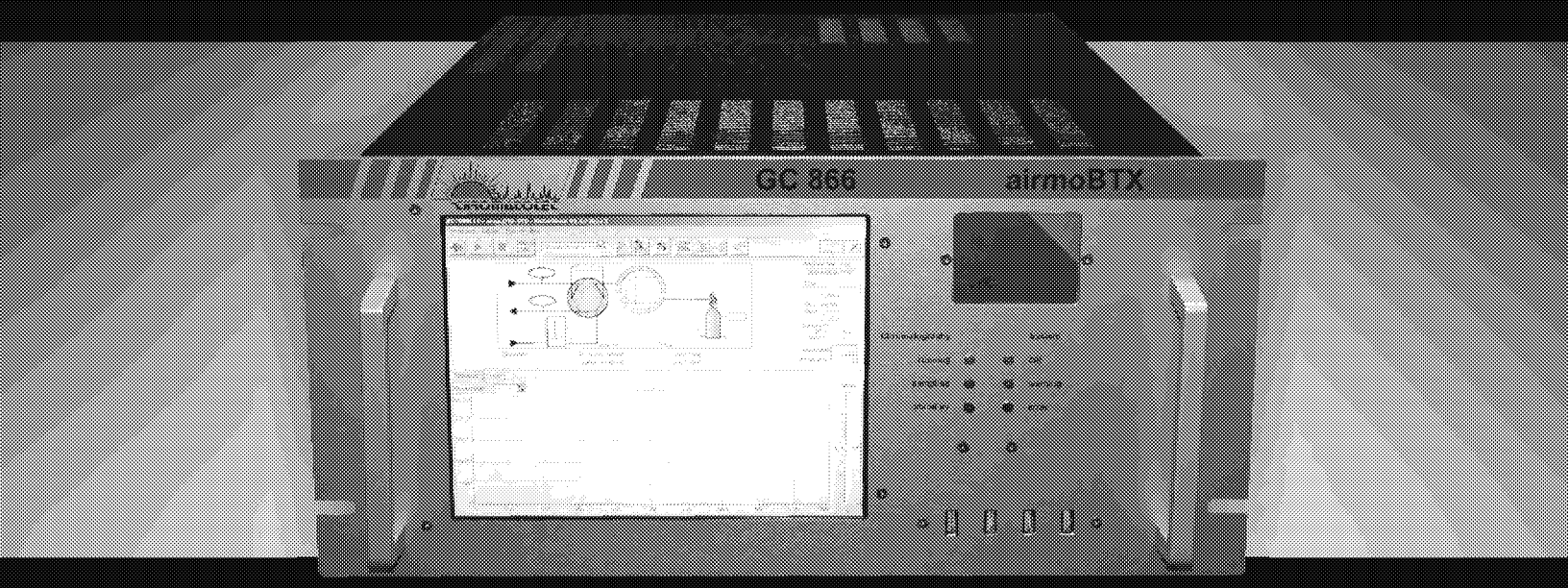
The MarkWest Program Manager will oversee the monitoring program established to obtain continuous and accurate air toxic and meteorological measurements at the Harmon Creek Gas Processing Plant. This monitoring will be conducted to satisfy the requirements of the Consent Decree. The primary objective of this monitoring site is to characterize upwind and downwind concentrations of propane, butane, pentane, hexane, benzene, toluene, ethylbenzene, xylene and all of its isomers, and total VOC's in the vicinity of the Harmon Creek Gas Processing Plant. The air toxics and meteorological monitoring systems will operate according to established protocols by the EPA to provide scientifically defensible air toxic and meteorological data. Data are expected to provide a true representation of air quality around the Harmon Creek Gas Processing Plant and fulfill the goals and objectives of the monitoring program which are defined in Section A.5. Following the procedures described in this QMP/QAPP, MarkWest personnel will ensure that the data quality objectives are met and the data will be representative of local meteorological and air quality conditions and be of acceptable quality accuracy, precision and completeness.

APPENDIX A

Air Toxic and Meteorological Equipment Specifications

CONSOLIDATED ANALYTICAL SYSTEMS

PAMS Auto-GC



Turn-Key Solutions

Consolidated Analytical Systems (CAS) understands the challenges of adding an Auto-Gas Chromatograph (Auto-GC) to an existing ambient monitoring station. The CAS Turn-Key Solution makes the transition from canister sampling to an Auto-GC as seamless as possible.

CAS Turn-Key Solution

The AirmOzone Auto-GC has been developed specifically to address the challenges of continuous online monitoring in the growing Photochemical Assessment Monitoring Stations (PAMS) network. The AirmOzone can be integrated into any existing Ambient Monitoring Station, and MODBUS output allows for communication with your current Data Acquisition System (DAS).

The AirmOzone is a rack-mountable, automated, rugged and industrial system that provides an ideal solution for network operators being tasked with continuous measurement of VOCs. This integrated solution provides unsurpassed separation of VOCs and exceptional stability and accuracy of results. The AirmOzone requires very little maintenance and offers the lowest cost of ownership on the market. The Flame Ionization Detector (FID) allows for no interference from competing compounds.

Some of the additional features of the AirmOzone include advanced color display, intuitive user interface, flexible I/O, and built-in data acquisition. Instrument set up, control, access to stored data, and diagnostic information is available through the front panel display, or via RS232, Ethernet, or USB com ports. VISTACHROM® software (included) provides local or remote connection. High and low threshold alarms for monitoring are user configurable. The proprietary VISTACHROM® software also enables remote monitoring and injection control as well as full traceability with onboard archiving of results.

- **Designed specifically for Integration into existing AQMS**
- **No compressed gas cylinders required.**
- **Turn-key solution from sample inlet to exhaust**
- **Constructed with site operator in mind**
- **24/7 national technical support**
- **Ethernet connectivity for remote access and monitoring**
- **Support gases generated on site**
- **Online, continuous sampling**
- **Low maintenance**
- **Automatic validation of results by Internal Permeation Tube**
- **Large, vivid, and durable color graphics display with user-friendly interface**

Consolidated Analytical Systems
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CONSOLIDATED ANALYTICAL SYSTEMS

PAMS Auto-GC

C2-C6

Compound(s) Analyzed:
Light VOC analysis: C_2 to C_6 , i.e. from Ethane through 1,3-Butadiene up to Benzene (and other C compounds)

Detection Range(s):
3 0.033 to 500 µg/m of 1,3-Butadiene

Lower Detectable Limit(s):
3 15 ppt (33 ng/m) for 1,3-Butadiene

Relative Standard Deviation:
Concentration: RSD <3% over 48 h
Retention time: RSD <0.3% over 48 h

Cycle time(s):
30 min (20 min option)
Sample Inlet (vacuum pump)

Sample Volume:
20 to 240 ml (programmable)
FID and Carrier Gas Flow Rate and Pressure
(UHP H_2): 30 ml/min; 2 bars

FID Flow Rate and Pressure (Air):
180 ml/min; 3 bars

C6-C12

Compound(s) Analyzed:
Up to 32 compounds from C6 to C12
C_6 (Hexane, Dimethylbutane) to C_{10} (Diethylbenzene, Naphthalene) and dodecane
BTEX
Halogen compounds (TO-14) or (PAMS)

Detection Range(s):
3 0.05 to 400 µg/m for Tri-methylbenzene
Lower Detectable Limit(s):
3 Tri-methylbenzene: 10 ppt or 0.05 µg/m
Benzene: 10 ppt in standard model; 1 ppt with airmoVOC Expert

Relative Standard Deviation:
Concentration: RSD <3% over 48 h
Retention time: RSD <0.3% over 48 h

Cycle time(s): 15 to 30 min
Sample Inlet (vacuum pump)

Sample Volume:
30 to 700 ml (programmable)

FID and Carrier Gas Flow Rate and Pressure (UHP H_2):
30 ml/min; 2 bars

FID Flow Rate and Pressure (Air):
180 ml/min; 3 bars

Physical Specifications

Operating Temperature Range:
18 to 25 °C, no more than ±1 °C change per hour

Dimensions (H x W x D):
8.7" x 19" x 23.6" (22.2cm x 48.2cm x 60cm)

Net Weight:
48.5 lbs (22 kg)

Options

Calibration Options:
Automatic validation and calibration
Internal Permeation Tube system (CALIBRATION system)
Multiple stream analysis with Multiplexer (2 to 6 streams)
User definable alarm thresholds

Mounting Options:
Rack mount brackets with chassis slides
Rack mount brackets with stationary shelf
Enclosed instrument rack with HVAC

Other Options:
24V power for transportable analysis
Explosion proof Exp box - Ex Specification Class 1 Div 2, Groups B,C,& D
Maintenance kit
UPS (Uninterrupted Power Supply)
Climate-control
Hydrogen and Zero Air Generators

Communication Specifications

Included I/O:
MODBUS/JBUS or MGS1 (RTU or ASCII)
RS232
RS485
Ethernet
4 USB com ports

Optional I/O:
4-20mA output
0-10V output

Contact Information

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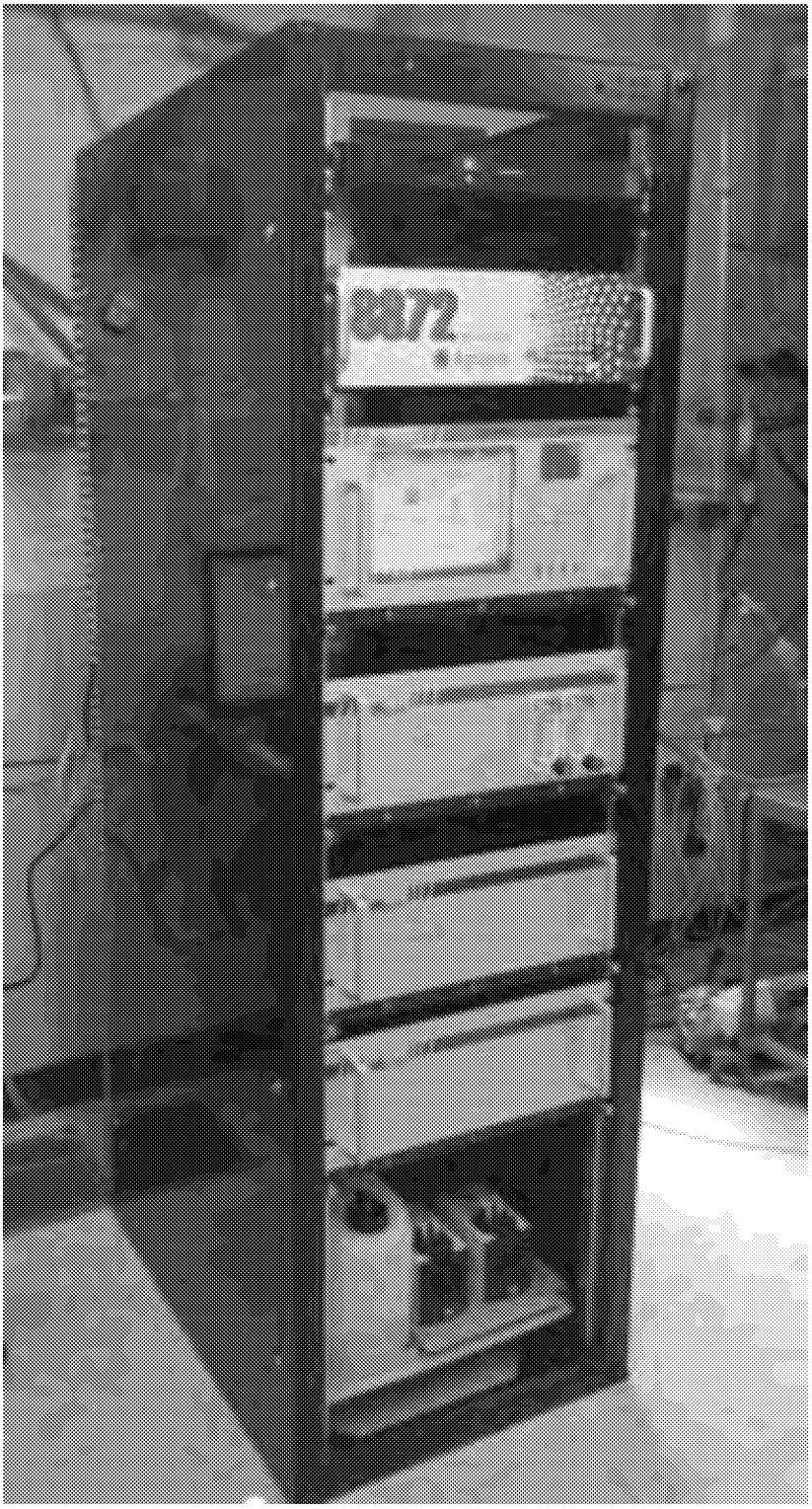

9001 Series Air Monitoring Shelter Technical Specifications

CONSOLIDATED ANALYTICAL SYSTEMS

Air Monitoring Shelter

- Standard size: 12ft (L) x 8ft (W) x 8ft (H)
- Other sizes available: 6ft/8ft/10ft/14ft/16ft (L) or other
- Standard 36" side door with door closer and handle/lock
- Standard 36" metal door for storage area access
- Exterior Aluminum Skin (Ivory)
- Exterior aluminum trim (corner angle and corner caps)
- Titanium Dioxide Waterproofing Agent
- Shelter designed by Leadership in Energy & Environmental Design Accredited Professional LEED AP)

Shelter Design

- Control room area: 12ft (L) x 8ft (W)
- Isolated storage area: Optional dependent on overall size
- Control room area insulation: R-25 equivalent
- Storage area insulation R-25 equivalent
- Stud-less wall construction minimizing thermal bridges (heat gain/loss)
- Fork-truck and crane lifting points
- Fiberglass reinforced paneling interior walls (white)
- Shelter tie down system for securing to the pad/piers

Interior Features

- Seamless Vinyl Flooring, Raised coin pattern
- 8' workbench, scratch, moisture and heat resistant
- Wall mounted cabinets, aluminum construction, with doors and shelf
- Two (2) Instrument Racks, 19" standard, with removable trays/slides for instruments
- Eight port glass sampling manifold with pump
- Exhaust Manifold
- Telephone/DSL Network Interface Device, one phone line and one DSL connection point
- Isolated Pump shelving in storage area or pump cabinet, including thermostatically controlled exhaust fan (305CFM), ventilation, bulkhead penetration for calibration lines and tubing management system
- Integrated calibration control system for automatic calibrations of each gaseous instrument with manifold pump control
- Four (4) Cylinder Mounting Brackets
- Wire and tubing management systems incorporated throughout the shelter

8' x 8' x 12' Air Monitoring Shelter in Tan

HVAC System

- 1.0 Ton (10,800Btu) with 3kW heating capacity
- Temperature stability +/-2°C within 20°C-30°C range
- Aluminum Finned Copper Coils
- Quiet Twin Blowers
- High Efficiency Rotary Compressor
- Green Refrigerant – R-410A Refrigerant-non ozone depleting (HFC)
- Galvanized zinc coated steel enclosure
- Automatic Condensate Disposal System
- Programmable Thermostat with auto-switch over

Electrical System

- Electrical System meets or exceeds NEC Regulations
- Premium SquareD Electrical Components
- 100A 120/240V 1PH Electrical System Ready
- 100A 120/240V 1PH Load Center, 20 circuit capacity,
- 100A 240V 1PH External Disconnect Box, NEMA 3R
- Metal Electrical Raceway, Surface Mount
- Three (3) Fluorescent Light Fixtures, 2 bulb, T8
- Four (4) Internal 120V 20A Duplex Outlets (Control Room)
- Two (2) dedicated instrument rack outlets, 120V 20A, ceiling mounted
- Four (4) Internal 120V 20A duplex outlets (Storage Area)
- Two (2) External 120V 20A GFCI Outlets (roof mounted)
- Uninterrupted Power Supplies (UPS)
    - 1500VA mounted in instrument racks

Consolidated Analytical Systems, Inc.
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9001 Series Air Monitoring Shelter
Technical Specifications

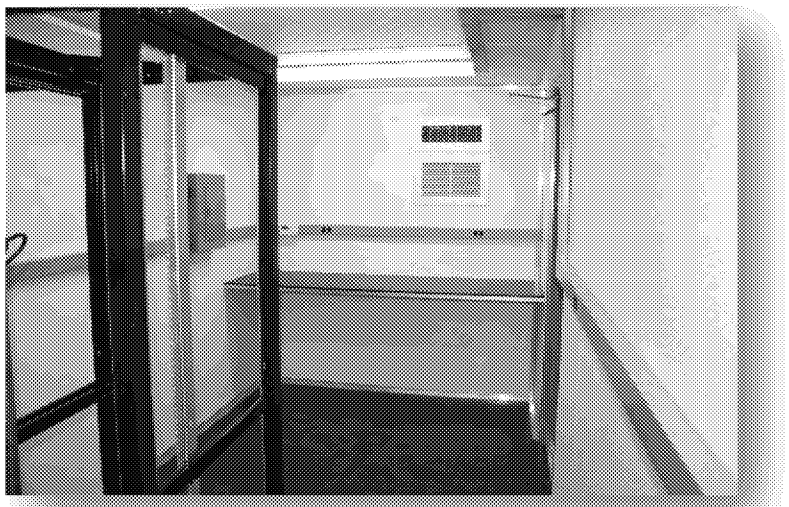
CONSOLIDATED ANALYTICAL SYSTEMS

Roof Features

- Roof configured for operation of samplers
- Aluminum Modular Safety Railing with kick-plate, OSHA compliant
- Aluminum Tread Plate, slip resistant
- Rubber Membrane Roofing
- Aluminum Access Staircase with railing
- Two (2) Roof penetrations for sample probes, 2"ID

Ten-meter Meteorological Tower

- Removable Tower Bracket mounted on the shelter
- Telescoping Aluminum 10-meter Mast with manual winch
- Aluminum cross-arm and brackets for met sensors
- Lightning protection & grounding kit for Met Tower
- Lightning protection device for meteorological sensors (RS-232 based)
- External water-proof signal cable box, 6" x 6" x 4"

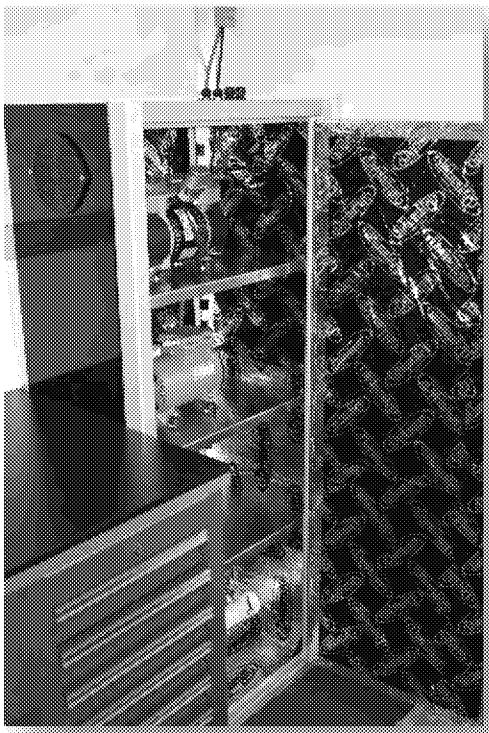


Shelter interior

Standard Warranty

- Twelve (12) months

8' x 8' x 12' Air Monitoring Shelter in dark gray



Workbench, Tool Chest, and Pump Cabinet to reduce heat, noise, and vibration

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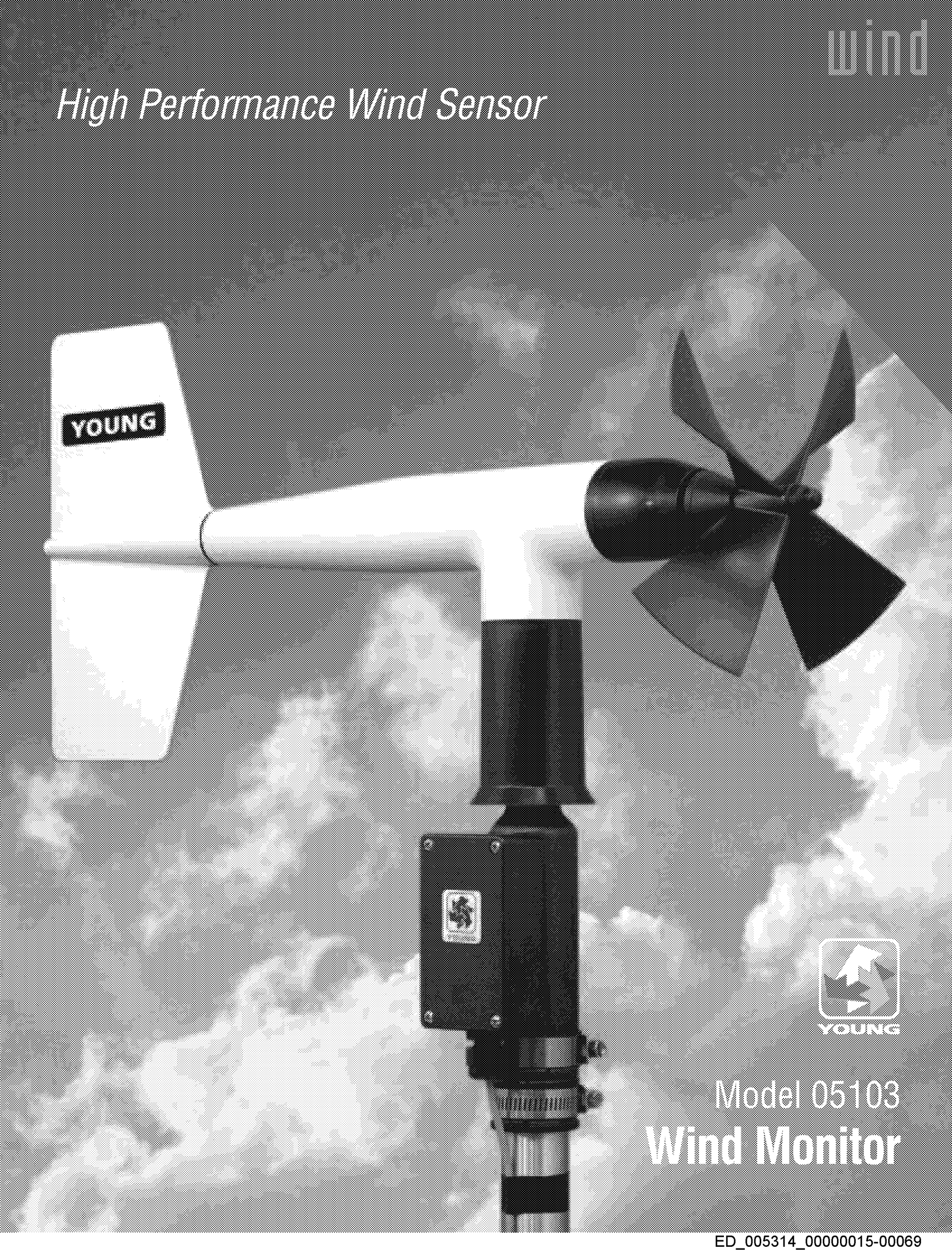
wind

High Performance Wind Sensor



YOUNG

Model 05103

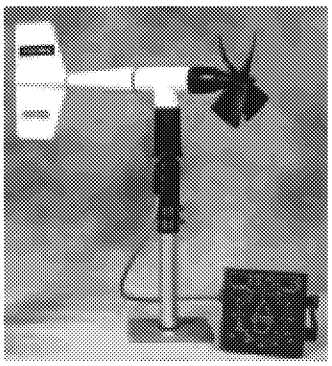
Wind Monitor

The Wind Monitor is a high performance, rugged wind sensor. Its simplicity and corrosion-resistant construction make it ideal for a wide range of wind measuring applications.

The wind speed sensor is a four blade helicoid propeller. Propeller rotation produces an AC sine wave voltage signal with frequency directly proportional to wind speed. Slip rings and brushes are eliminated for increased reliability.

The wind direction sensor is a rugged yet lightweight vane with a sufficiently low aspect ratio to assure good fidelity in fluctuating wind conditions. Vane angle is sensed by a precision potentiometer housed in a sealed chamber. With a known excitation voltage applied to the potentiometer, the output voltage is directly proportional to vane angle. A mounting orientation ring assures correct realignment of the wind direction reference when the instrument is removed for maintenance.

The instrument is made of UV stabilized plastic with stainless steel and anodized aluminum fittings. Precision grade, stainless steel ball bearings are used. Transient protection and cable terminations are in a convenient junction box. The instrument mounts on standard 1 inch pipe.



For offshore and marine use, **Model 05106, Wind Monitor-MA** features special waterproof bearing lubricant and a sealed, heavy duty cable pigtail in place of the standard junction box. Separate signal conditioning for voltage or current outputs is available.

The Wind Monitor is available with two additional output signal options. **Model 05103V** offers calibrated 0-5 VDC outputs, convenient for use with many dataloggers. **Model 05103L** provides a calibrated 4-20 mA current signal for each channel, useful in high noise areas or for long cables (up to several kilometers). Signal conditioning electronics are integrated into the sensor junction box.

Specifications

Range:
Wind speed: 0-100 m/s (224 mph)
Azimuth: 360° mechanical, 355° electrical (5° open)

Accuracy:
Wind speed: ±0.3 m/s (0.6 mph) or 1% of reading
Wind direction: ±3 degrees

Threshold:*
Propeller: 1.0 m/s (2.2 mph)
1.1 m/s (2.4 mph) 05106
Vane: 1.1 m/s (2.4 mph) 05103

Dynamic Response:*
Propeller distance constant (63% recovery) 2.7 m (8.9 ft)
Vane delay distance (50% recovery) 1.3 m (4.3 ft)
Damping ratio: 0.3
Damped natural wavelength: 7.4 m (24.3 ft)
Undamped natural wavelength: 7.2 m (23.6 ft)

Signal Output:
Wind speed: magnetically induced AC voltage, 3 pulses per revolution. 1800 rpm (90 Hz) = 8.8 m/s (19.7 mph)
Azimuth: analog DC voltage from conductive plastic potentiometer – resistance 10K Ω, linearity 0.25%, life expectancy – 50 million revolutions

Power Requirement:
Potentiometer excitation: 15 VDC maximum

Dimensions:
Overall height: 37 cm (14.6 in)
Overall length: 55 cm (21.7 in)
Propeller: 18 cm (7 in) diameter
Mounting: 34 mm (1.34 in) diameter (standard 1 inch pipe)

Weight:
Sensor weight: 1.0 kg (2.2 lbs)
Shipping weight: 2.3 kg (5 lbs)

**Nominal values, determined in accordance with ASTM standard procedures.*

MODEL 05103V 0-5 VDC outputs

Power Requirement:
8-24 VDC (5 mA @ 12 VDC)

Operating Temperature:
-50 to 50° C

Output Signals:
0-5.00 VDC full scale

MODEL 05103L 4-20 mA outputs

Power Requirement:
8-30 VDC (40 mA max.)

Operating Temperature:
-50 to 50° C

Output Signals:
4-20 mA full scale

CE *Complies with applicable CE directives.*
Specifications subject to change without notice.

Ordering Information — MODEL

WIND MONITOR	05103
WIND MONITOR 0-5 VDC OUTPUTS	05103V
WIND MONITOR 4-20 mA OUTPUTS	05103L
WIND MONITOR-MA (MARINE MODEL)	05106
WIND SENSOR INTERFACE (FOR USE WITH 05106) 0-5 VDC	05603C
WIND LINE DRIVER (FOR USE WITH 05106) 4-20 mA	05631C

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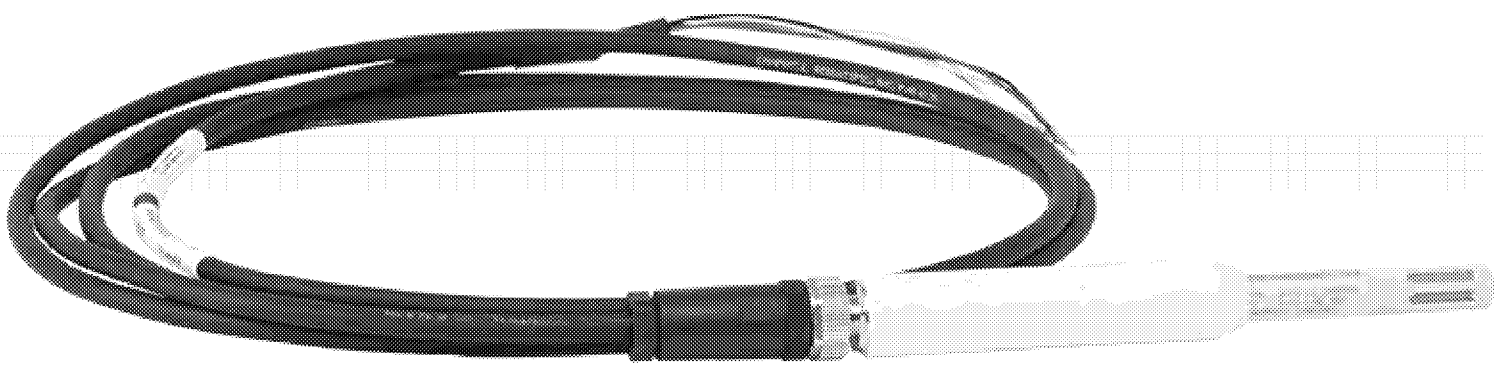
CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

EE181

Air Temperature and Relative Humidity Probe

Accurate, Rugged

Ideal for long-term, unattended applications



Overview

The EE181 is a rugged, accurate air temperature and relative humidity (RH) probe that is ideal for long-term, unattended applications. It includes a proprietary coating on the RH element that increases the life of the element and protects it from dirt, dust, salt, or other contaminants. A 1000 Ω PRT measures air temperature for the -40° to +60°C range. For optimum results, the EE181 should be recalibrated annually.

Benefits and Features

- Well-suited for long-term, unattended applications
- Accurate, rugged, reliable
- Outstanding, long-term stability
- Wide operating temperature range
- Compact and easily interchangeable
- Low power consumption
- Compatible with all Campbell Scientific dataloggers

Sensor Mounts

When exposed to sunlight, the EE181 must be housed in a 10-plate solar radiation shield. Campbell Scientific recommends the MetSpec RAD10E, which uses a double-louvered design that offers improved sensor protection from driving rain, snow, and insect intrusion. This shield also has lower self-heating in bright sunlight combined with higher temperatures (> 24°C (~75°F)) and low wind speeds (< 2 m s^{-1} (~4.5 mph)) giving a better measurement.

The EE181 will work with R. M. Young 10-plate solar radiation shields (41003-5 or 41003-5A) but these shields require a special adapter (pn 28415) to accommodate the sensor girth.

The RAD10E and 41003-5 attach to a crossarm, mast, or user-supplied pipe with a 2.5 to 5.3 cm (1.0 to 2.1 in) outer diameter. The 41003-5A solar radiation shield attaches to a CM500-series pole or a user-supplied pole with a 5.1 cm (2.4 in) outer diameter.

Ordering Information

Air Temperature and Relative Humidity Probe

EE181-L Air temperature/RH probe with user-specified cable length. Enter cable length, in feet, after the -L. Must choose a cable termination option (see below).

Cable Termination Options (choose one)

-PT Cable terminates in stripped and tinned leads for direct connection to a datalogger's terminals.

-PW Cable terminates in connector that attaches to a prewired enclosure.

-C Cable terminates in a connector for attachment to a CS110 Electric Field Meter or ET107 weather station.

Mounts

RAD10E 10-plate MetSpec solar radiation shield with U bolts for attachment to a Campbell Scientific crossarm or mast.

41003-5 10-plate R. M. Young solar radiation shield with U bolts for attachment to a Campbell Scientific crossarm or mast. Requires the 28415 adapter (see below).

41003-5A 10-plate R. M. Young solar radiation shield with band clamp for attachment to a CM500-series or similar pole. Requires the 28415 adapter (see below).

28415 Adapter for mounting the sensor in a 41003-5 or 41003-5A solar radiation shield.

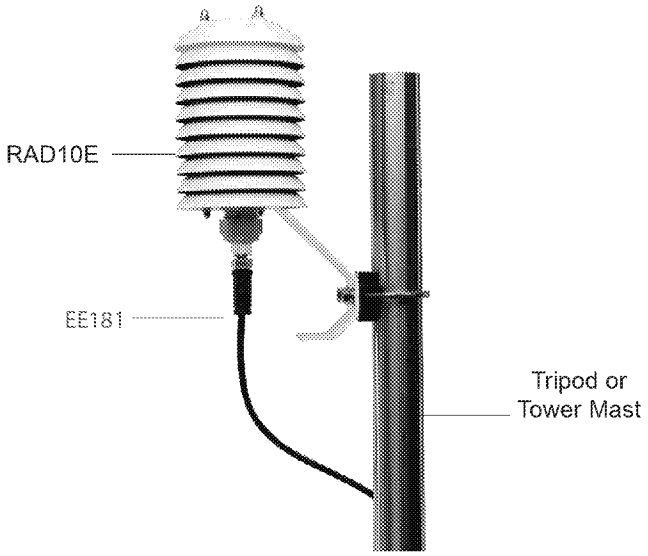
Cable Length Recommendations[1]

2 m Height	CM106B[2]	CM110[2]	CM115[2]	CM120[2]	UT10	UT20	UT30
3.4 m (11 ft)	4.3 m (14 ft)	4.3 m (14 ft)	5.8 m (19 ft)	7.3 m (24 ft)	4.3 m (14 ft)	7.3 m (24 ft)	11.3 m (37 ft)

Notes:
1. The lengths assume the sensor is mounted at the end of a 2 ft crossarm.
2. The lengths assume the enclosure is mounted to the tripod mast. If it is mounted to the leg base, add 0.6 m (2 ft) to the cable length.

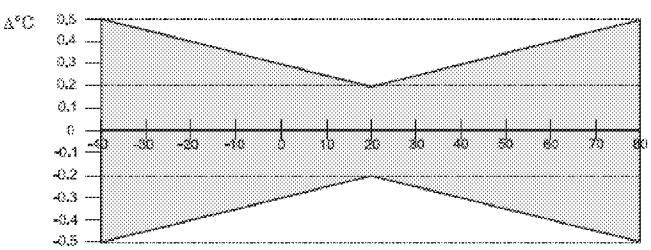
Specifications

- Supply Voltage: 7 to 30 Vdc (typically powered by the datalogger's 12 V supply)
- Current Consumption: < 1.2 mA
- Filter Description: 30 µm pore size, stainless steel mesh
- Start-up Time: 2 s
- Length: 16.0 cm (6.3 in)
- Sensor Diameter: 2.1 cm (0.83 in)
- Weight with 5 m cable: 290 g (10.2 oz)
- Compliance: View the EU Declaration of Conformity at www.campbellsci.com/ee181-l
- Housing
  Body Material: plastic
  Classification: IP65



Air Temperature

- Air Temperature Sensor: 1000 Ω Platinum Resistance Thermometer (PRT)
- Measurement Range: -40° to +60°C
- Output Signal Range: 0 to 1 Vdc
- Accuracy:



Relative Humidity (RH)

- Sensor: Capacitance
- Measurement Range: 0 to 100% RH, non-condensing
- Output Signal Range: 0 to 1 Vdc
- Temperature Dependence: typically 0.03% RH/°C
- Accuracy (including hysteresis, non-linearity, and repeatability)

Temperature	Accuracy
-15° to +40°C	±(1.3 + 0.003 * RH reading) % RH (0 to 90% RH) ± 2.3% RH (90 to 100% RH)
-25° to +60°C	± (1.4 + 0.01 * RH reading) % RH
-40° to +60°C	± (1.5 + 0.015 * RH reading) % RH

CS106

Barometric Pressure Sensor

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

The CS106 barometer uses Vaisala's BAROCAP silicon capacitive sensor to measure barometric pressure over a 500 to 1100 millibar range. The CS106 outputs a linear signal of 0 to 2.5 Vdc, allowing it to be directly connected to Campbell Scientific dataloggers. The CS106 is compatible with all of our contemporary dataloggers and many of our retired dataloggers (e.g., CR510, CR10(X), CR23X).

Construction and Mounting

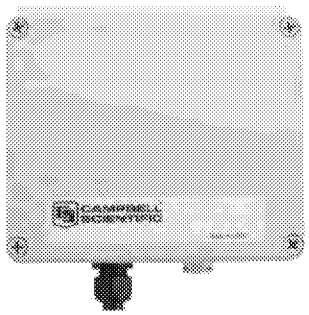
The CS106 is encased in a plastic shell (ABS/PC blend) fitted with an intake valve for pressure equilibration. It includes a 2.5 ft cable and a terminal strip for datalogger power and signal connections. The CS106 is typically mounted next to the datalogger inside an ENC12/14 or larger enclosure. The ENC100 is available for housing the CS106 in its own enclosure.

Ordering Information

Barometric Pressure Sensor	
CS106	Vaisala PTB110 Barometer (500 to 1100 mb), with 30 in. cable.

Accessories	
The following accessories are used when the barometer will be housed in a different enclosure than the datalogger.	
ENC100	6.7 in. by 5.5 in enclosure for housing only the CS106.
CABLE5CBL-L	5-conductor, 24 AWG cable with drain wire and Santoprene jacket. Enter cable length, in feet, after the -L. Must choose a cable termination option (see below).

Cable Termination Options (choose one)	
-PT	Cable terminates in pigtails for direct connection to datalogger's terminals.
-PW	Cable terminates in a connector for attachment to a prewired enclosure.



The ENC100 is a very small enclosure that can house one CS106. It includes a backplate, compression fitting, vent, and mounting bracket.

The CS106 includes a switching circuit that allows the datalogger to power the barometer only during measurement, which reduces power consumption. Sensor warm-up and measurement time is one second minimum.

Manufacturer's Specifications

Total Accuracy[1]:	±0.3 mb @ +20°C ±0.6 mb @ 0° to 40°C ±1.0 mb @ -20° to +45°C ±1.5 mb @ -40° to +60°C
Linearity:	±0.25 mb
Hysteresis:	±0.03 mb
Repeatability:	±0.03 mb
Calibration Uncertainty:	±0.15 mb
Long-Term Stability:	±0.1 mb per year
Operating Temperature:	-40° to +60°C
Dimensions:	2.7" x 3.8" x 1.1" (6.8 cm x 9.7 cm x 2.8 cm)
Weight:	3.2 oz (90 g)
Supply Voltage:	10 to 30 Vdc
Current Consumption:	<4 mA (active), <1 µA (quiescent)
Settling Time:	1 second to reach full accuracy after power-up
Response Time:	500 ms to reach full accuracy after a pressure step

[1]*The root sum squared (RSS) of end point non-linearity, hysteresis, repeatability, and calibration uncertainty.*

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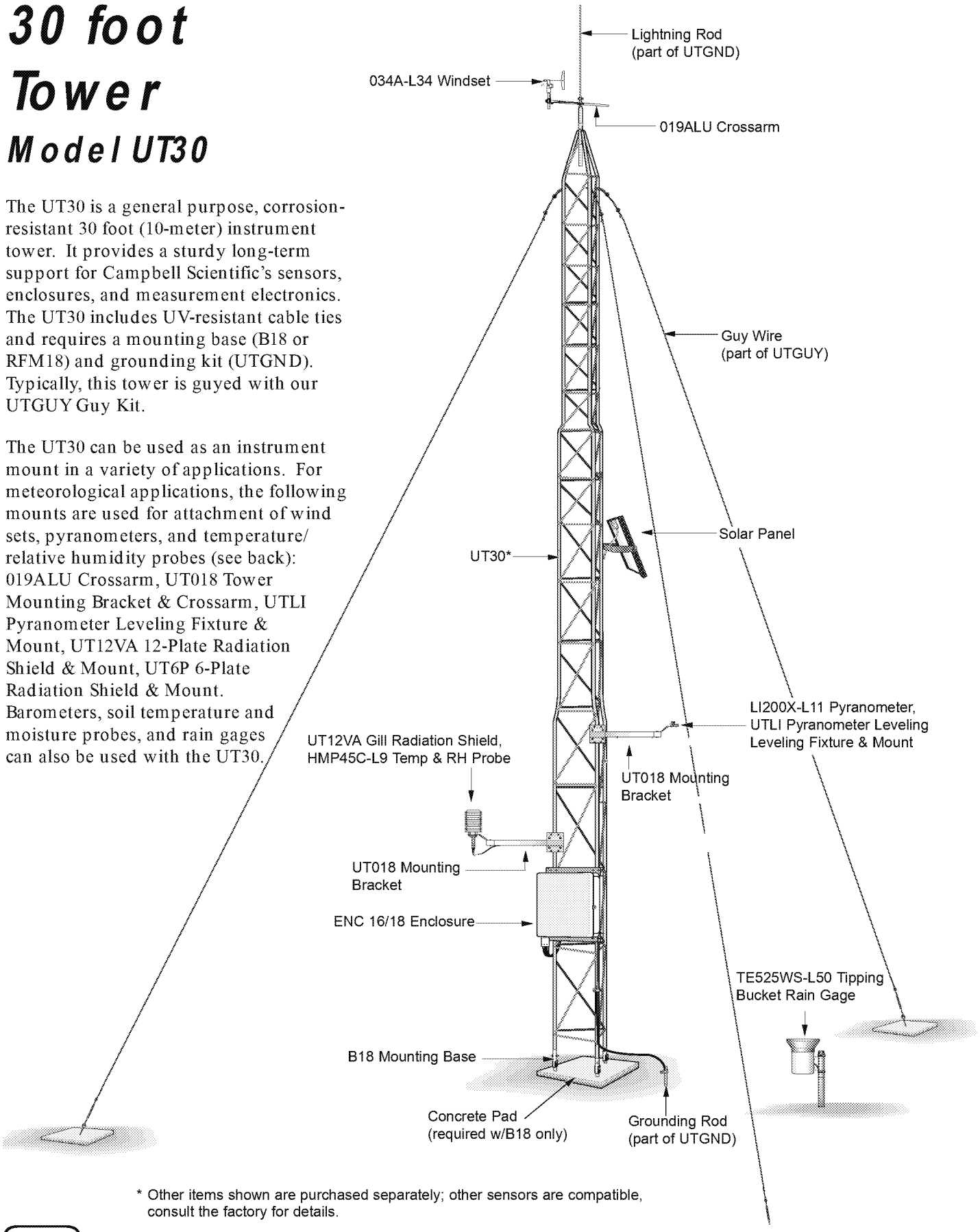
Printed April 2011

30 foot Tower

Model UT30

The UT30 is a general purpose, corrosion-resistant 30 foot (10-meter) instrument tower. It provides a sturdy long-term support for Campbell Scientific's sensors, enclosures, and measurement electronics. The UT30 includes UV-resistant cable ties and requires a mounting base (B18 or RFM18) and grounding kit (UTGND). Typically, this tower is guyed with our UTGUY Guy Kit.

The UT30 can be used as an instrument mount in a variety of applications. For meteorological applications, the following mounts are used for attachment of wind sets, pyranometers, and temperature/ relative humidity probes (see back): 019ALU Crossarm, UT018 Tower Mounting Bracket & Crossarm, UTLI Pyranometer Leveling Fixture & Mount, UT12VA 12-Plate Radiation Shield & Mount, UT6P 6-Plate Radiation Shield & Mount. Barometers, soil temperature and moisture probes, and rain gages can also be used with the UT30.



* Other items shown are purchased separately; other sensors are compatible, consult the factory for details.

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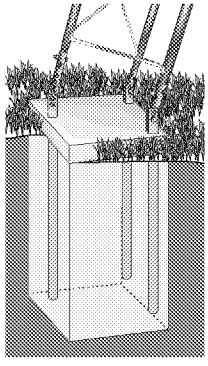
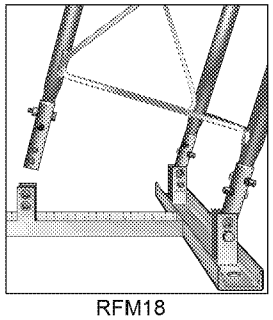
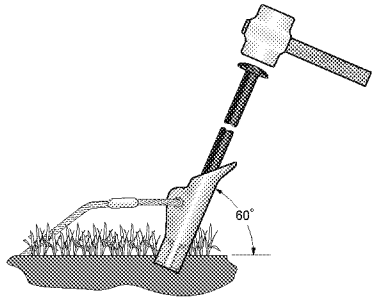
Specifications

Crossarm measurement height:	33 ft (10 m)
Shipping weight:	65 lbs (29 kg)
Material:	Hardened Drawn 6063-T832 aluminum
OD of vertical pipe:	1" (2.5 cm)
OD of cross support pipes:	0.375" (0.953 cm)
Guyed tower area requirements:	~34 ft diameter
Required concrete pad dimensions (B18 base only):	36"L x 36"W x 48"D (91 x 91 x 122 cm) This assumes heavy soil; light shifting, or sandy soils require a larger concrete pad.

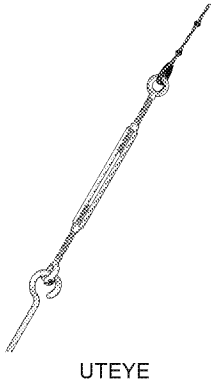
UT30 Accessories


B18


RFM18



UTDUK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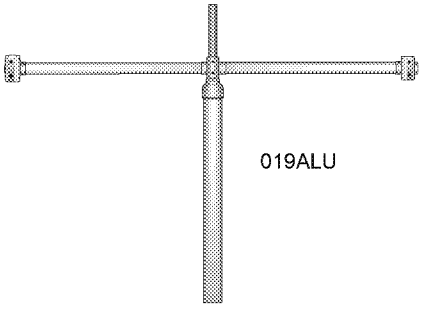
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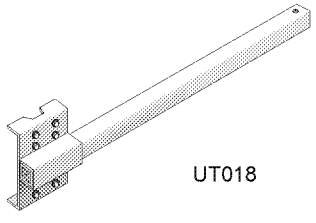
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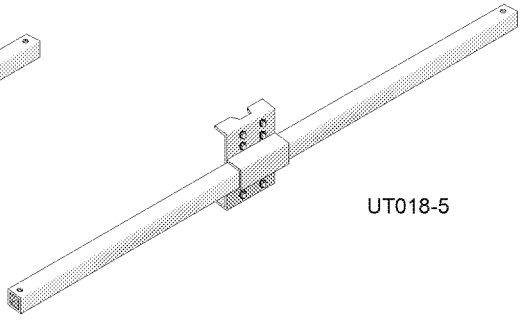
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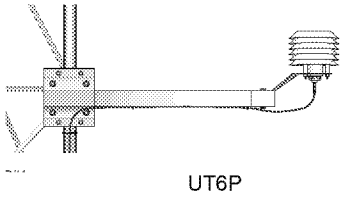
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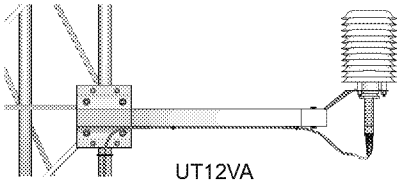
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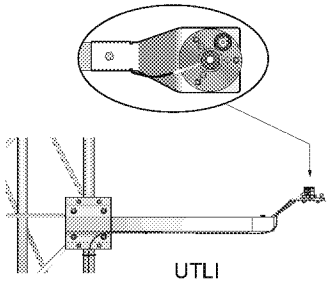
UTLI

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Printed June, 2000

RavenXT-Series

Sierra Wireless Airlink Digital Cellular Modems

The RavenXT-series modems are full-duplex devices that transmit data to the local cellular tower. A PC retrieves the data from the cellular tower via the Internet*. Internet communications provide faster communication rates and eliminate dialing delays and long distance fees.

The following modems are offered:

- **RavenXTV**—Code Division Multiple Access (CDMA) modem configured for Verizon networks
- **RavenXTG**—General Packet Radio Service (GPRS) modem configured for AT&T networks

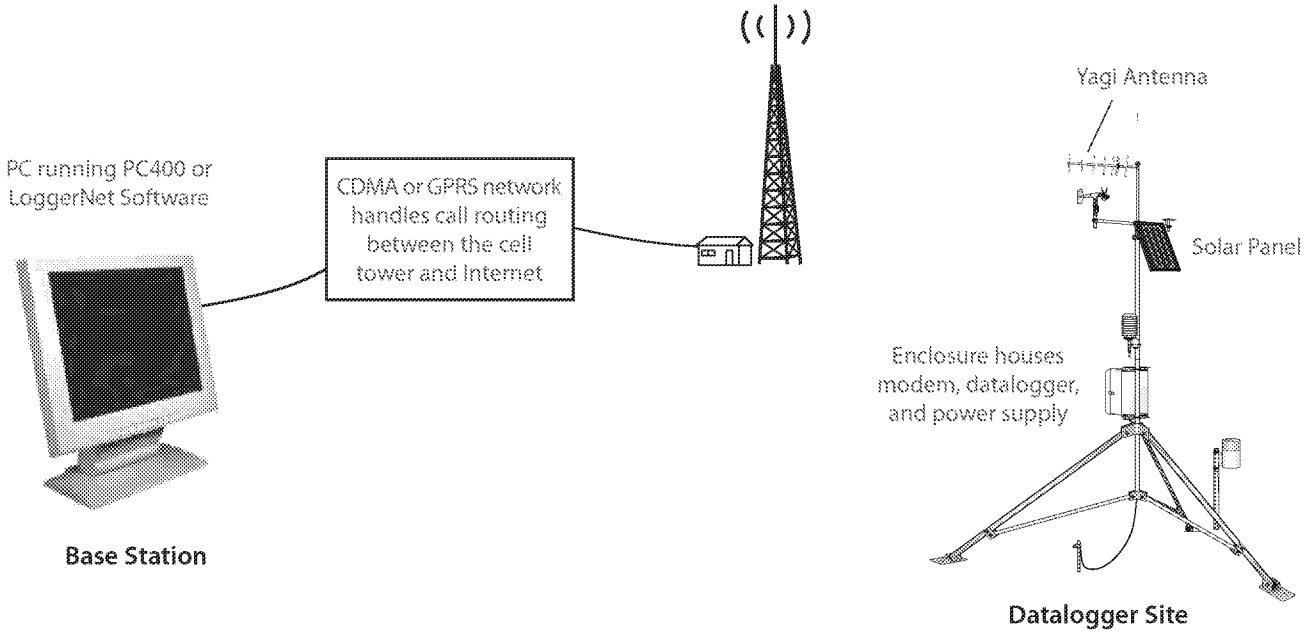
Features

- Eliminates the dialing delays and long distance fees that land-line phone modems experience
- Allows simultaneous communications with multiple dataloggers in the network
- Housed in a rugged aluminum case
- Operates over a wide operating temperature range (see specifications)

Cellular Coverage

Before purchasing a digital cellular modem, ensure that there is a CDMA or GPRS network with coverage at the datalogger site. For the RavenXTV, you'll need to contact Verizon and ask them about coverage. For the RavenXTG, a coverage map is available at: www.wireless.att.com/coverageviewer/

Typical System*



**The RavenXTV uses 1xRTT/EVDO to communicate over the Internet. It can also use IS-95 to communicate over standard telephone lines. Contact Campbell Scientific for system requirements if using IS-95.*

Establishing Cellular Service

RavenXTV

Call Verizon at 1-888-384-1775 and set up either a static or dynamic IP account[1]. When setting up the account, you will need the ESN number, which is listed on the modem's label. You will also need to request the *unrestricted IP*. Verizon's *Broadband Plan* is recommended.

RavenXTG

Call AT&T at 1-800-331-0500 and ask for an *unrestricted data account* for a GPRS modem. Either a static IP account or a dynamic IP account needs to be established. After the account has been set up, mobile termination needs to be configured onto the account to make the modem accessible through the Internet. This is done by adding an *I2gold APN*[2] or *custom APN*[3] to the account. A data account with an *I2gold APN* will have a Static IP address.

After establishing service, AT&T will provide a SIMM card for each modem. In some cases, the SIMM card can be picked up at the local AT&T store.

Datalogger Site Equipment

Digital Cellular Modem

The RavenXTV and RavenXTG are shipped with a power cable, our Resource CD, and a CD containing the Airlink software and the Airlink manual. The modems are configured using the following software:

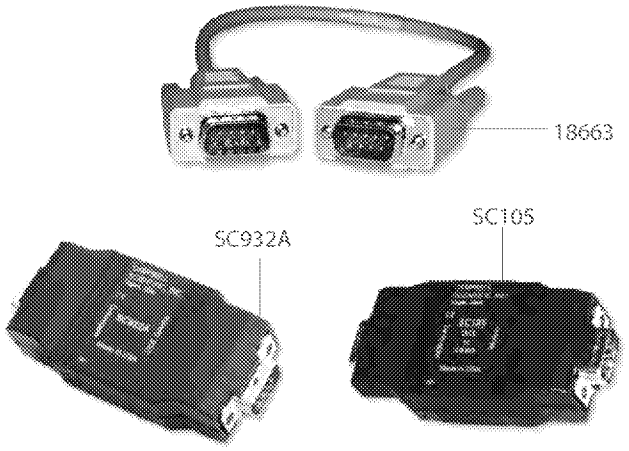
- **Airlink AceManager software**—activates the modem and configures the generic parameters of the modem.
- **Campbell Scientific's Raven CDMA Template (RavenXTV) or Raven GPRS Template (RavenXTG)**—used with Airlink AceManager software to configure the modem. The template sets up the Raven serial interface, which is specific to Campbell Scientific systems. The Raven CDMA Template and Raven GPRS Template are available, at no charge, from: www.campbellsci.com/downloads

Network connection information can be viewed using the Airlink AceManger or Airlink AceView software.

Datalogger Connections

All of our contemporary and many of our retired dataloggers are compatible. The datalogger connects with the modem using one of the following devices:

- **18663 Null Modem Cable**—connects the modem directly to the datalogger's RS-232 port. This cable is the only option available for connecting the modem to a CR200(X)-series datalogger.
- **SC105 DCE Interface**—connects the modem to the datalogger's CS I/O port via an SC12 cable. The SC105 is recommended for PakBus® dataloggers when the RS-232 port is unavailable.
- **SC932A DCE Interface**—connects the modem to the datalogger's CS I/O port via an SC12 cable. The SC932A is recommended for mixed-array dataloggers when the RS-232 port is unavailable.



One of the above is required to connect the datalogger to the modem. The best choice for your application depends on the datalogger you are using.

Power Considerations

A power cable included with the modem connects to the datalogger's 12 V or switched 12 V terminal. Connection to the switched 12 V terminal allows the datalogger to switch power to the modem during scheduled transmission intervals, thereby conserving power. When using the switched 12 V terminal, the modem can be powered with a BP12 battery, CH100 regulator, and SP10 solar panel. For help on analyzing your system's power requirements, refer to our Power Supply product brochure or application note.

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[1] *A static IP account eliminates the need for a third party Dynamic Domain Name System (DDNS) such as IP manager. The DDNS translates the domain name to a dynamic IP address so that the modem can be contacted as if it had a static IP address.*

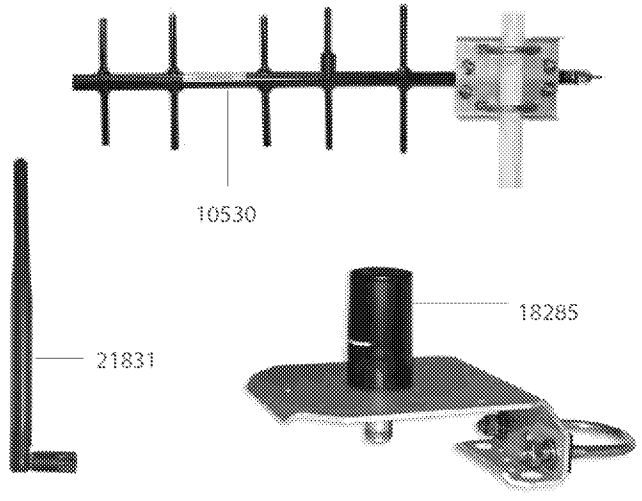
[2] *At one time, feature code G821 was used instead of the I2gold APN. Feature code G821 has been discontinued, and all RavenXTGs need either an I2gold APN or custom APN.*

[3] *A custom APN may offer more efficient routing and better security for large cellular phone networks. It will take four to six weeks for AT&T to develop a custom APN and cost about $250.00.*

Antennas

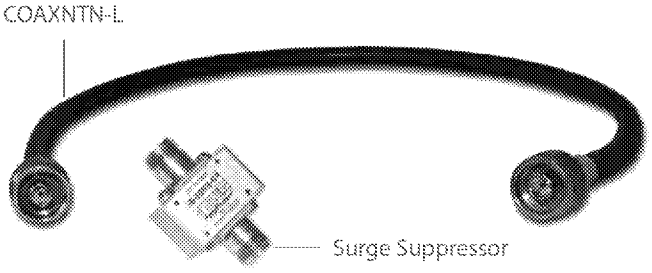
A choice of four antennas is offered for the modems. Contact an Applications Engineer for help in determining the best antenna for your application.

- **21831 0 dBd, ½ Wave Dipole Whip Antenna**—supports the 800 MHz band. It is intended for locations that have strong cellular coverage. This antenna attaches directly to the modem's SMA connector and must reside in an environmental enclosure or building. It has an articulating knuckle joint that can be oriented vertically or at right angles.
- **18285 1 dBd, Omnidirectional Antenna**—covers both the 800 MHz and 1.9 GHz bands. It includes a mounting bracket for attaching the antenna to a crossarm, tripod, tower, or pole. Connection to the modem requires an antenna cable (*see right column*).
- **20679 800 MHz/0 dBd and 1.9 GHz/3 dBd Omnidirectional Antenna**—includes a mounting bracket for attaching the antenna to a crossarm, tripod, tower, or pole. Connection to the modem requires an antenna cable (*see right column*).
- **10530 9 dBd, Yagi Antenna**—supports the 800 MHz band and is intended for sites near the edge of the cellular coverage. It includes a bracket for attachment to a mast or pole (outer diameter of up to 1.5" (3.8 cm)). Some sites may require the CM230 mount (see *Adjustable Angle Mounting Kit*). Connection to the modem requires an antenna cable (*see right column*).



Above are antennas used with the RavenXT-series digital cellular modems. The 20679 antenna is not shown.

Antenna Cables/Surge Suppressor



Installations that are susceptible to lightning should use the COAXNTN cable and 19533 surge protector kit.

Typically, a 21847 or COAXSMA-L cable is used with a 18285, 20679, or 10530 antenna. Both of these cables have a type N male connector on the antenna end and an SMA connector on the transceiver end. They differ in their length:

- **21847 Antenna Cable with 12-ft Length**
- **COAXSMA-L Antenna Cable with User-specified Length**—enter cable length, in feet, after the L. Length should not exceed 20 ft (6 m).

Use the following when the modem is in an environment susceptible to lightning or electrostatic buildup:

- **COAXNTN-L** antenna cable with type N male to type N male connectors (requires 19533)—specify length, in feet, after the L. Cable lengths longer than 20 ft will weaken the signal strength.
- **19533 Antenna Surge Protector Kit**—includes one COAXSMA-L1.5 cable. A COAXNTN-L cable is required (see above).

Adjustable Angle Mounting Kit

The CM230 Adjustable Angle Mounting Kit allows the 10530 Yagi antenna to be aimed at the service provider's antenna.

Enclosures and Mounting Bracket

An ENC12/14, ENC14/16, or ENC16/18 environmental enclosure can house the modem, datalogger, and power supply. The modem is secured to the enclosure's backplate via the 14394 Mounting Bracket.

Base Station Requirements

- PC running PC400 or LoggerNet Datalogger Support Software.
- Access to the Internet.

Specifications

	RavenXTV	RavenXTG
Technology	CDMA 1xRTT, EVDO Rev. A, CDMA IS-95, dual band	GPRS (MS-12), quad band
Bands	**Dual band:** 800 MHz Cellular, 1900 MHz PCS	**Quad band:** 850/1900 MHz; 900/1800 MHz
Transmit Frequency	1850 to 1910 MHz and 824 to 849 MHz	**850/1900 MHz:** 824 to 849 MHz; 1850 to 1910 MHz **900/1800 MHz:** 890 to 915 MHz; 1710 to 1785 MHz
Transmit Power	1.0 W for 1900 MHz; 0.8 W for 850 MHz	1.0 W for 1900 MHz; 0.8 W for 850 MHz
Receiver Frequency	1930 to 1990 MHz and 869 to 894 MHz	**850/1900 MHz:** 869 to 894 MHz; 1930 to 1990 MHz **900/1800 MHz:** 935 to 960 MHz; 1805 to 1880 MHz
CDMA or GPRS Throughput	up to 80 kbps (CDMA)	up to 70 kbps (GPRS)
RS-232 Data Rates	1200 bps to 115.2 kbps	1200 bps to 115.2 kbps
Serial Interface	RS-232, DB9-F	RS-232, DB9-F
Serial Protocols	AT Commands, PPP, SLIP, UDP/IP, TCP/IP	AT Commands, PPP, SLIP, UDP, TCP
RF Antenna Connector	50 Ohm SMA	50 Ohm SMA
Input Current Range	50 to 250 mA	40 to 250 mA
Typical Current Drain (at 12 Vdc)	50 mA dormant (idle for 10 to 20 seconds), 120 mA transmit/receive	50 mA dormant (idle for 10 to 20 seconds), 120 mA transmit/receive
Input Voltage Range	6 to 28 Vdc	6 to 28 Vdc
Operating Temperature Range	-30° to +70°C	-30° to +65°C
Operating Humidity Range	5% to 95% RH non-condensing	5% to 95% RH non-condensing
Status LEDs	Power, Network, Signal, Activity	Power, Network, Signal, Activity
Dimensions	3"W x 1"D x 4"L (7.6 x 2.5 x 10 cm)	3"W x 1"D x 4"L (7.6 x 2.5 x 10 cm)
Weight	<1 lbs (<0.5 kg)	<1 lbs (<0.5 kg)

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CR1000 Specifications

Electrical specifications are valid over a -25° to +50°C, non-condensing environment, unless otherwise specified. Recalibration recommended every three years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

PROGRAM EXECUTION RATE

10 ms to one day @ 10 ms increments

ANALOG INPUTS (SE1-SE16 or DIFF1-DIFF8)

8 differential (DF) or 16 single-ended (SE) individually configuredinput channels. Channel expansion provided by optional analog multiplexers.

RANGES and RESOLUTION: Basic resolution (Basic Res) is the A/D resolution of a single A/D conversion. A DIFF measurement with input reversal has better (finer) resolution by twice than Basic Res.

Range (mV)[1]	*DF Res (µV)*[2]	*Basic Res (µV)*
±5000	667	1333
±2500	333	667
±250	33.3	66.7
±25	3.33	6.7
±7.5	1.0	2.0
±2.5	0.33	0.67

[1]Range overhead of ~9% on all ranges guarantees that full-scale values will not cause over range.
[2]Resolution of DF measurements with input reversal.

ACCURACY[3]:
±(0.06% of reading + offset), 0° to 40°C
±(0.12% of reading + offset), -25° to 50°C
±(0.18% of reading + offset), -55° to 85°C (-XT only)

[3]Accuracy does not include the sensor and measurement noise. Offsets are defined as:
Offset for DF w/input reversal = 1.5•Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3•Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

ANALOG MEASUREMENT SPEED:

Integration Type/Code	*Integration Time*	*Settling Time*	*Total Time*[4] *SE w/ No Rev*	*Total Time*[4] *DF w/ Input Rev*
250	250 µs	450 µs	~1 ms	~12 ms
60 Hz[5]	16.67 ms	3 ms	~20 ms	~40 ms
50 Hz[5]	20.00 ms	3 ms	~25 ms	~50 ms

[4]Includes 250 µs for conversion to engineering units.
[5]AC line noise filter.

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±2.5 mV input range (digital resolution dominates for higher ranges).
250 µs Integration: 0.34 µV RMS
50/60 Hz Integration: 0.19 µV RMS

INPUT LIMITS: ±5 Vdc

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

INPUT VOLTAGE RANGE W/O MEASUREMENT CORRUPTION: ±8.6 Vdc max.

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±90 nA @ 85°C

INPUT RESISTANCE: 20 GΩ typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):
±0.3°C, -25° to 50°C
±0.8°C, -55° to 85°C (-XT only)

ANALOG OUTPUTS (VX1-VX3)

3 switched voltage, sequentially active only during measurement.

RANGE AND RESOLUTION:

Channel	*Range*	*Resolution*	*Current Source/Sink*
(VX 1–3)	±2.5 Vdc	0.67 mV	±25 mA

ANALOG OUTPUT ACCURACY (VX):
±(0.06% of setting + 0.8 mV), 0° to 40°C
±(0.12% of setting + 0.8 mV), -25° to 50°C
±(0.18% of setting + 0.8 mV), -55° to 85°C (-XT only)

VX FREQUENCY SWEEP FUNCTION: Switched outputs provide a programmable swept frequency, 0 to 2500 mv square waves for exciting vibrating wire transducers.

PERIOD AVERAGE

Any of the 16 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading + resolution), where resolution is 136 ns divided by the specified number of cycles to be measured.

INPUT AMPLITUDE AND FREQUENCY:

Voltage Gain	*Input Range (±mV)*	*Signal (peak to peak) Min (mV)*[6]	*Signal (peak to peak) Max (V)*[7]	*Min Pulse Width (µV)*	*Max*[8] *Freq (kHz)*
1	250	500	10	2.5	200
10	25	10	2	10	50
33	7.5	5	2	62	8
100	2.5	2	2	100	5

[6]Signal centered around Threshold (see PeriodAvg() instruction).
[7]With signal centered at the datalogger ground.
[8]The maximum frequency = 1/(twice minimum pulse width) for 50% of duty cycle signals.

RATIOMETRIC MEASUREMENTS

MEASUREMENT TYPES: Provides ratiometric resistance measurements using voltage excitation. 3 switched voltage excitation outputs are available for measurement of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Optional excitation polarity reversal minimizes dc errors.

RATIOMETRIC MEASUREMENT ACCURACY:[9,10,11]
±(0.04% of Voltage Measurement + Offset)

[9]Accuracy specification assumes excitation reversal for excitation voltages < 1000 mV. Assumption does not include bridge resistor errors and sensor and measurement noise.
[10]Estimated accuracy, ΔX (where X is value returned from the measurement with Multiplier = 1, Offset = 0):
BrHalf() instruction: $\Delta X = \Delta V_r/V_x$
BrFull() instruction $\Delta X = 1000 \cdot \Delta V_r/V_x$, expressed as $mV \cdot V^{-1}$.
ΔV^{-1} is calculated from the ratiometric measurement accuracy. See Resistance Measurements Section in the manual for more information.
[11]Offsets are defined as:
Offset for DIFF w/input reversal = 1.5•Basic Res + 1.0 µV
Offset for DIFF w/o input reversal = 3•Basic Res + 2.0 µV
Offset for SE = 3•Basic Res + 3.0 µV
Excitation reversal reduces offsets by a factor of two.

PULSE COUNTERS (P1-P2)

2 inputs individually selectable for switch closure, high frequency pulse, or low-level ac. Independent 24-bit counters for each input.

MAXIMUM COUNTS PER SCAN: 16.7×10^6

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH-FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW-LEVEL AC MODE: Internal ac coupling removes ac offsets up to ±0.5 Vdc.
Input Hysteresis: 12 mV RMS @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

Sine Wave (mV RMS)	*Range(Hz)*
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

DIGITAL I/O PORTS (C1-C8)

8 ports software selectable, as binary inputs or control outputs. Provide on/off, pulse width modulation, edge timing, subroutine interrupts / wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UARTs), and SDI-12 communications. SDM communications are also supported.

LOW FREQUENCY MODE MAX: <1 kHz

HIGH-FREQUENCY MODE MAX: 400 kHz

SWITCH-CLOSURE FREQUENCY MAX: 150 Hz

EDGE TIMING RESOLUTION: 540 ns

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 Ω

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 kΩ with inputs <6.2 Vdc
220 Ω with inputs ≥6.2 Vdc

SERIAL DEVICE/RS-232 SUPPORT: 0 TO 5 Vdc UART

SWITCHED 12 VDC (SW-12)

1 independent 12 Vdc unregulated source is switched on and off under program control. Thermal fuse hold current = 900 mA at 20°C, 650 mA at 50°C, 360 mA at 85°C.

CE COMPLIANCE

STANDARD(S) TO WHICH CONFORMITY IS DECLARED:
IEC61326:2002

COMMUNICATIONS

RS-232 PORTS:
DCE 9-pin: (not electrically isolated) for computer connection or connection of modems not manufactured by Campbell Scientific.
COM1 to COM4: 4 independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 Vdc UART
Baud Rates: selectable from 300 bps to 115.2 kbps.
Default Format: 8 data bits; 1 stop bits; no parity
Optional Formats: 7 data bits; 2 stop bits; odd, even parity

CS I/O PORT: Interface with telecommunications peripherals manufactured by Campbell Scientific.

SDI-12: Digital control ports C1, C3, C5, and C7 are individually configured and meet SDI-12 Standard v 1.3 for datalogger mode. Up to 10 SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals

PROTOCOLS SUPPORTED: PakBus, AES-128 Encrypted PakBus, Modbus, DNP3, FTP, HTTP, XML, HTML, POP3, SMTP, Telnet, NTCIP, NTP, Web API, SDI-12, SDM.

SYSTEM

PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core running at 7.3 MHz)

MEMORY: 2 MB of flash for operating system; 4 MB of battery-backed SRAM for CPU usage and final data storage; 512 kB flash disk (CPU) for program files.

REAL-TIME CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional.

REAL-TIME CLOCK RESOLUTION: 10 ms

SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 16 Vdc

INTERNAL BATTERIES: 1200 mAh lithium battery for clock and SRAM backup that typically provides three years of backup

EXTERNAL BATTERIES: Optional 12 Vdc nominal alkaline and rechargeable available. Power connection is reverse polarity protected.

TYPICAL CURRENT DRAIN at 12 Vdc:
Sleep Mode: < 1 mA
1 Hz Sample Rate (1 fast SE meas.): 1 mA
100 Hz Sample Rate (1 fast SE meas.): 6 mA
100 Hz Sample Rate (1 fast SE meas. w/RS-232 communication): 20 mA
Active external keyboard display adds 7 mA (100 mA with backlight on).

PHYSICAL

DIMENSIONS: 23.9 x 10.2 x 6.1 cm (9.4 x 4 x 2.4 in); additional clearance required for cables and leads.

MASS/WEIGHT: 1 kg / 2.1 lb

WARRANTY

3 years against defects in materials and workmanship.

APPENDIX B

Corrective Action Report

MSi
Meteorological Solutions Inc.
A Trinity Consultants Company

Corrective Action Report

Project Name_____ Project Number_____

A. Identification of a Problem or Deficiency:

To:_____
From:_____
Date:_____

Summary:_____
_____
_____

B. Proposed Corrective Action:

To:_____
From:_____
Date:_____

Recommended Action:_____
_____
_____

C. Results of Proposed Action:

To:_____
From:_____
Date:_____

Results:_____
_____

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www.metsolution.com | info@metsolution.com

APPENDIX C

Standard Operating Calibration Procedures for Consolidated Analytical Systems AirmOzone Auto-Gas Chromatographs and Meteorological Sensors

MSi Meteorological Solutions Inc. A Trinity Consultants Company **STANDARD OPERATING PROCEDURE**	Title: AIRMOVOC C_2-C_6 Startup and Stop Procedure	
	Number: SOP 166	Page: 1 of 3
	Revision Number: 0	Effective Date: 6/15/2018
Approval: Date:		Concurred By:

STARTING THE AIRMOVOC C_2-C_6

Note: Before turning on the supply gases (hydrogen, air), you must verify that the pressure reducing valves are turned off because the piezo valve and the pressure regulator are pre-adjusted and a big pressure variation are very dangerous for the pre-adjustment.

Check that all the tubes are connected correctly and are gas tight.

1. Set the Hydrogen pressure at 2 bars.

2. Set the Zero Air pressure at 3 bars.

3. Switch in the sample vacuum pump.

4. Switch on the AIRMOVOC C_2-C_6. The green LED "OK" and the red LED "**STAND BY**" LIGHT. It is possible that errors occurred before the instrument was switched off, in which case, the error information will have been saved by the system. If this is the case, the yellow LED "ALARM" or the red LED "**FAULT**" will light immediately after the instrument is switched on again. The error will be passed to the computer before or by latest the end of the first chromatogram. When the AIRMOVOC C_2-C_6 is switch on, the initial parameters are charged in the instrument. These parameters are:

   - Oven temperature: 36°C
   - FID temperature: 170°C
   - Column pressure: Depend on the application

   These parameters are fixed and should not be modified.

5. Switch on the computer and start or install the chromatography software.

STOP THE AIRMOVOC C_2-C_6

In any case, before SHUT Down, the power supply with the general SWITCH on the rear panel, it will be necessary to correctly stop the instrument.

1. Stop the analysis by clicking on the icon  . The "**stand by**" and "ok" LEDs of the RS232 card must be lit and any other.

2. Wait for some minutes to obtain the initial parameters of the oven (**36°C), sampling off, desorption of the TRAP, etc.** The reason is that the carrier gas is controlled by the piezo valve. If the instrument is shutdown during the function, the piezo valve is closed and no carrier gas ways through the analytical column and the TRAP. It is a big cause of damage to these elements.

3. When the oven temperature is near 36°C-38°C, LOG OFF the instrument with the icon  . **BE CAREFUL, if the icon is yellow, the instrument is in function and doesn't be shut down.**

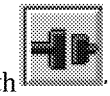
4. When the instrument is LOG OFF and in **stand by** position (the LEDs "**stand by**" and "ok" of the RS232 card must be lit), no communication subsists with the software and the instrument can be switch off.

EMERGENCY STOP

Sometimes, an error occurs during the functioning of the instrument, caused by the system or by a human manipulation. It is possible to completely loose or not the communication with the instrument. In this case, the alone response will be to make a RESET of the instrument and of the PC. Two possibilities:

SOFTWARE RESET

- **STOP THE MEASURE** on the ON LINE window with the icon  .
- Wait for some minutes to obtain the initial parameters of the oven (36°C), **sampling off, Desorption of the TRAP**, etc.
- **LOG OFF** the instrument with the icon  .
- **CLOSE** the acquisition software.
- **START the ServiceGC** application.
- **Select the serial number of your instrument and the communication port.**
- **Click on LOG ON.**
- Click in the same time on **RESET** button (Service GC) and **PULL UP** the **RESET** button on the rear or front face. The **RESET** button will be in the high position until the "**Stand By**", "**Error**" and "Ok" leds on the RS232 card must be lit.
- When the **dialog activity** icon blinks, the instrument communicates with the PC and you can transfer the Setup with the **Tranfert setup** button. The led "**Error**" will be lit off.
- Stop the ***ServiceGC*** utility with the ***Close*** button.

- Restart the acquisition software and LOG ON with  .
- Reload the working sequence with  and restart the analyzer with  .

Sometimes, software RESET is not sufficient and hardware RESET will be necessary.

HARDWARE RESET

- STOP THE MEASURE with  . Wait for some minutes to obtain the initial parameters of the oven (**36°C), sampling off, Desorption of the TRAP**, etc. If the communication is impossible with the acquisition software (use Service GC utility to STOP analyses).
- **SHUT DOWN** the instrument, open the COVER and disconnect the battery from the CPU card.
- **Wait for some minutes** to empty all memory of the CPU card. **During this manipulation, it will be recommended to make a PC RESTART.**
- **Reconnect** the battery.
- **PULL UP the RESET** button and SWITCH **ON** the instrument. The RESET button will be in the high position until the "**Stand By**", "**Error**" and "OK" leds on the RS232 card must be lit.
- **START** the **ServiceGC application.**
- **Select the serial number of your instrument and the communication port.**
- **Click on LOG ON.**
- The **Transfert setup** is automatic and the led "**Error**" will be lit off.
- **Stop** the ***ServiceGC*** utility with the Close button and **Restart** the acquisition software.
- **LOG ON** the instrument and load the working sequence with the icon  and start the measure with the icon  .

After a RESET, the first cycle only permits the use to initialize the instrument. There is no TRAP desorption or acquisition during this cycle.

MSi Meteorological Solutions Inc. A Trinity Consultants Company **STANDARD OPERATING PROCEDURE**	Title: AIRMOVOC C_6-C_{12} Startup and Stop Procedure	
	Number: SOP 167	Page: 1 of 4
	Revision Number: 0	Effective Date: 6/15/2018
Approval: Date:		Concurred By:

STARTING THE AIRMOVOC C_6-C_{12}

Note: Before turning on the supply gases (hydrogen, air), you must verify that the pressure reducing valves are turned off because the piezo valve and the pressure regulator are pre-adjusted and a big pressure variation are very dangerous for the pre-adjustment.

Check that all the tubes are connected correctly and are gas tight.

1. Set the Hydrogen pressure at 2 bars.

2. Set the Zero Air pressure at 3 bars.

3. Switch on the sample vacuum pump.

4. Switch on the analyzer. The green LED "OK" and the red LED "**STAND BY**" LIGHT. It is possible that errors occurred before the instrument was switched off, in which case, the error information will have been saved by the system. If this is the case, the yellow LED "ALARM" or the red LED "**FAULT**" will light immediately after the instrument is switched on again. The error will be sent to the computer before or at the end of the first chromatogram. When the AIRMOVOC C_6-C_{12} is switched on, the initial parameters are charged in the instrument. These parameters are:

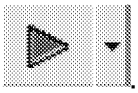
   - Oven temperature: 36°C
   - FID temperature: 170°C
   - Column pressure: 470 hPa

   These parameters are fixed and should not be modified.

5. At the same time, the PC is switched on. Windows "embedded" starts with Chromatotec user "pass word": CETOMRIA or Administrator user "pass wprd":1234 and the PC opens automatically the Vistachrom software. Select the "super user" level and you type 1234 as the Password.

6. Log on the instrument with the PC  .

7. Load the working sequence with  .

8. Start the analysis with the touchpad  . The first cycle permits the system to be initialized.

STOP THE AIRMOVOC C_6-C_{12}/AIRMOVOC BTEX

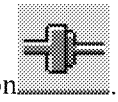
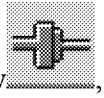
In any case, before SHUT Down, the power supply with the main SWITCH on the rear panel, it will be necessary to correctly stop the instrument. At the end of the method, wait some minutes until the LEDS "stand by" and "ok" are lit.

Classical Stop

1. Click on the icon  . In this case, the analyzer stops at the end of the analyzing method. Wait some minutes until the "**stand by**" and "ok" LEDs of the RS232 board light before closing Vistachrom software.

   In any case, the "**stand by**" and "ok" LEDs of the RS232 board must be lit.

2. Wait until the end of the cycle and wait some minutes to obtain the initial parameters of the oven (**36°C), sampling off, desorption of the TRAP, etc.** The reason is that the carrier gas is controlled by the piezo valve. If the instrument is shutdown during the function, the piezo valve is closed and no carrier gas goes through the analytical column and the TRAP which can cause damage to these elements.

3. LOG OFF the instrument with the icon  . Be careful, if the icon is yellow  , the instrument is in function and shouldn't be shut down. When the icon is blue  the instument can be switched off.

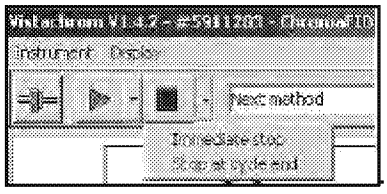
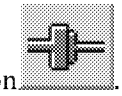
4. When the instrument is LOG OFF and in standby position (the LEDs "**stand by**" and "ok" of the RS 232 board must be lit), no communication exists with the software and the instrument can be switched off.

5. When the oven temperature is near 36°C-38°C, LOG OFF the instrument with the icon  . **BE CAREFUL, if the icon is yellow, the instrument is in function mode and shouldn't be shut down.**

EMERGENCY STOP

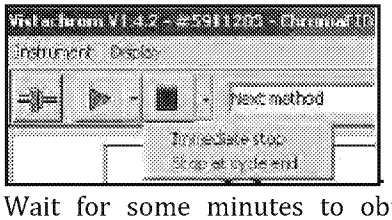
Sometimes an error occurs during the functioning of the instrument. It is possible to completely lose or not communicate with the instrument. In this case, the response will be to make a RESET of the instrument and of the PC. The two possibilities are software reset or hardware reset.

SOFTWARE RESET

- **STOP THE MEASURE** at the end of the method on the ON LINE window with the icon 
- Wait some minutes to obtain the initial parameters of the oven (36°C), **sampling off, Desorption of the TRAP**, etc.
- **LOG OFF** the instrument with the icon  .
- **CLOSE** the acquisition software **Vistachrom**.
- **START the ServiceGC** application.
- **Select the serial number of your instrument and the communication port**.
- **Click on "LOG ON" button**.
- Click on "**RESET**" button (Service GC) and **PULL UP** the **RESET** button on the rear or front face. The **RESET** button will be in the high position until the "**Stand By**", "**Error**" and "Ok" on the RS232 card must be lit.
- When the **dialog activity** icon blinks, the instrument communicates with the PC and the user can transfer the Setup with the **Tranfert setup** button. The led "**Error**" will be lit off.
- Stop the ***ServiceGC*** utility with the ***Close*** button.
- Restart the acquisition software and LOG ON with  .
- Load the working sequence with  and restart the analyzer with  .

Sometimes, software RESET is not sufficient and hardware RESET will be necessary.

HARDWARE RESET

- **STOP THE MEASURE** at the end of the method on the ON LINE window with the icon 
- Wait for some minutes to obtain the initial parameters of the oven (**36°C), sampling off, Desorption of the TRAP**, etc. If the communication is impossible with the acquisition software (use Service GC utility to STOP analyses).
- **SHUT DOWN** the instrument, open the COVER and disconnect the battery from the CPU board.

- **Wait for some minutes** to empty all memory of the CPU card. **During this manipulation, it will be recommended to make a PC RESTART.**
- **Reconnect** the battery on the CPU board.
- **SWITCH ON** the instrument with the internal tow positions switch. The leds "**Stand By**", "**Error**" and "OK" on the RS232 card must be lit.
- **START** the **ServiceGC application.**
- **Select the serial number of your instrument and the communication port.**
- **Click on "LOG ON" button.**
- The **Transfert setup** is automatic and the led "**Error**" will be lit off.
- **Stop** the ***ServiceGC*** utility with the "**Close**" button and **Restart** the acquisition software VIstachrom.
- **LOG ON** the instrument with  and load the working sequence with the icon  and start the measure with the icon  .

After a RESET, the first cycle only permits the initialization of the instrument. There is no TRAP desorption, no acquisition during this cycle, etc.

MSi Meteorological Solutions Inc. A Trinity Consultants Company **STANDARD OPERATING PROCEDURE**	Title: AIRMOVOC C_6-C_{12} Calibration with External Standard	
	Number: SOP 168	Page: 1 of 2
	Revision Number: 0	Effective Date: 6/15/2018
Approval: Date:		Concurred By:

Calibrate with a standard gas cylinder from 10 ppb to 100 ppb.

1. Stop the analyzer at the end of the cycle.
2. Purge 3 times (minimum) the manometer of the cylinder.
3. Connect the solenoid valve to the analyzer power board.

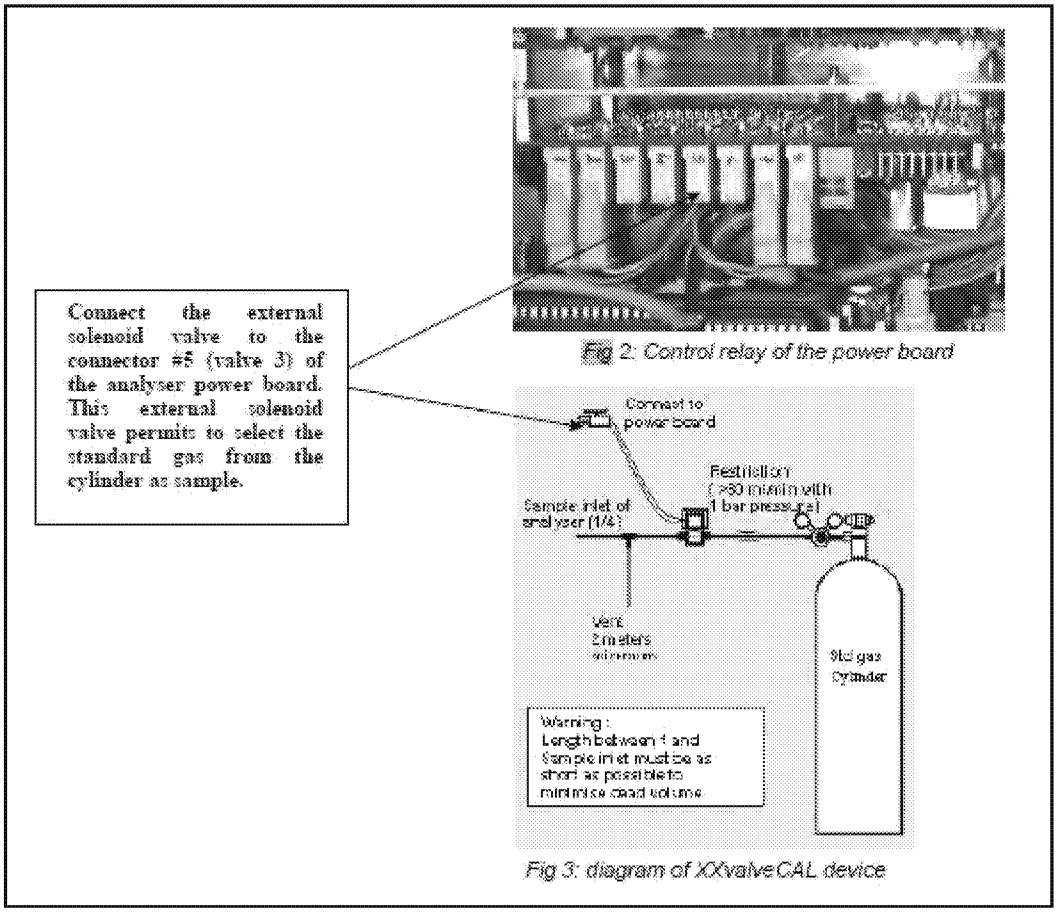


Fig 2: Control relay of the power board

Fig 3: diagram of XXvalveCAL device

4. Measure the flow of standard gas before the external solenoid valve (30 ml/min).

5. Select and load the calibration sequence in VISTACHROM. The working sequence permits in a first time to calibrate with precision the analyzer and in a second time to certify the permeation tube. This sequence is not cyclic so the analyzer will stop at the end of the sequence.

6. Start the analyzer and wait for the analysis results.

7. Go to Peak Viewer software and compare calculated concentrations with expected concentrations.

READJUSTMENT OF CALIBRATION (PARAMETER Base Sensitivity)

How to Calculate the New Base Sensitivity

$BS = [Area / (C_C \times V)] \times 10^{-6}$ C_C: concentration calculated in µg/m³

V: volume of the sample in m³

If the concentration is not equal to the concentration expected, you have to change the value of the base sensitivity:

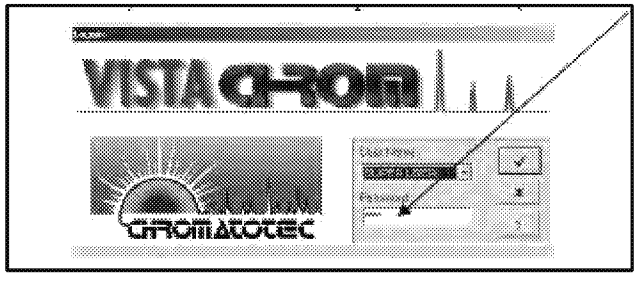
$$\textbf{New BS} = \textbf{BS} \times (C_C/C_E)$$

Example: Expected concentration is 110 µg/m³ (C_E) and you measure 119.72 (C_C) with a BS of 4244 (µa/ng).

$$\textbf{New BS} = 4244 * (119.72/110) = 4619.0 \text{ rounded } 4620 \text{ (µa/ng)}$$

How to Change the Base Sensitivity

1. You must be identified by VISTACHROM with Super User name (Password:1234)



2. Stop the analyzer at the end of the cycle.

3. Click on the "GC parameters setup" icon  , Tab "Information".

4. Change BS by the New BS and click on OK to validate the configuration.

5. Start the analysis.

6. Check if the New BS is taken into account to calculate the new concentrations at the end of the analysis.

MSi Meteorological Solutions Inc. A Trinity Consultants Company	STANDARD OPERATING PROCEDURE	Title: AIRMOVOC C_6-C_{12} Permeation Tube Replacement	
		Number: SOP 169	Page: 1 of 2
		Revision Number: 0	Effective Date: 6/15/2018
Approval: Date:			Concurred By:

To replace the permeation tube, utilize the following procedure.

1. The used permeation tube will have a permeation rate around 32 ng/min at 45°C or 15 ng/min at 45°C or 40°C.

2. Stop the analyzer and stop the sampling pump.

3. Insert the new permeation tube in the oven installed inside the analyzer.

4. Test to gastight of the permeation oven by plugging the VENT.

5. Measure the air dilution flow with a flowmeter on the VENT.

6. Switch on the analyzer but don't start the measurement. Leds **STANDBY** and OK light.

7. Log on the analyzer with the "service GC" and activate the relay 7/valve 5 to have a measurement of the total air dilution flow on the vent.

8. Calculate coarsely the concentration of the permeation tube. For example: Tube of Benzene with a permeation rate of 32 nm/min at 45°C and a total dilution flow of 250 ml/min. The benzene concentration will be:

$$\frac{32}{0.250} = 128 \text{ ng/l or } \mu g/m^3$$

The molecular weight of benzene is 78.1 g/mol and the molecular volume is 20°C is 24.04 l/mol.
The concentration of the permeation tube in ppb will be:

$$\frac{128\ x\ 24.04}{78.11} = 39.4 \text{ ppb}$$

9. Logg of Service GC and log the GC on Vistachrom.

10. The user will wait for some hours before using the calculation method to have a stabilized permeation tube.

11. Switch on the sampling pump.

12. Load the working sequence and start the analysis without activated the auto-calibration option. A new base sensitivity will be calculated but not updated in the GC configuration.

13. Open the viewer and reprocess the 4 stabilized calibration chromatograms obtained with the substances table of the ambient air method.

14. With the viwer, select the RECALC button to have the concentration measured by the analyzer.

15. If the reprocessed calibration analyses give for example 39.5 ppb, 40.1 ppb, 40.2 ppb abd 40.0 ppb, the mean concentration is 39.95 rounded to 40.0 ppb.

16. Open the Configuration Setup and note the original base sensitivity and make the next calculation:
    Mean concentration obtained after chromatograms re-identification: 40.0 ppb
    Theoretical concentration: 39.4 ppb.
    Original Base sensitivity: 4000 (ua by µg)
    The new base sensitivity is:

$$\frac{40.0\ x\ 4000}{39.4} = 4060.91$$

    The new Base sensitivity will be updated in the Setup GC configuration. In this example, the value will be 4060.

17. Start the analyzer and wait for the analysis results.

18. Go to Peak Viewer software and compare calculated concentrations with expected concentrations.

MSI Meteorological Solutions Inc. A Trinity Consultants Company	**STANDARD OPERATING PROCEDURE**	Title: Wind Direction Calibration	
		Number: SOP M11	Page: 1 of 2
		Revision Number: 6	Effective Date: 09/18/2014 06/20/2008 (Rev. 5)
Approval: Date:			Concurred By:

The wind direction calibration will be performed by comparing the wind direction sensor readouts on the DAS and chart recorder with known wind directions established by using a theodolite or precision compass. Several points over the measurement range are verified using a direction template, assigned compass reference points, or established distant sighting targets. Differences between reference and sensor measured directions are recorded. Direction vane starting threshold will be checked using a torque disc or torque watch gauge.

Calibration Personnel Responsibilities

The person performing the calibration is responsible for the certification of the calibration standard before conducting calibrations. The calibration technician will calculate the results of the calibration and will inform the Project Manager of the preliminary findings.

Calibration Instrumentation and Forms

The calibration technician conducting the calibration will bring the following equipment to the site:

1. Professional classic pocket transit or precision compass with tripod,
2. R.M. Young Model 18212 Vane Angle Fixture,
3. R.M. Young Model 18331 Vane Torque Gauge,
4. Current magnetic declination angle for site to be calibrated,
5. Calibration field data sheets, and
6. (optional) Theodolite and True North solar angle program for computer.

Procedures

Calibration procedures are in accordance with the guidelines of the EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV, Version 2.0 Final (EPA, March 2008).

1. For wind direction instruments that have crossarms, prior to lowering the tower or the crossarm, determine the crossarm alignment by sighting along it using a precision compass corrected for magnetic declination. Current magnetic declination is obtained using the latitude/longitude or UTM coordinates of the site and a magnetic declination calculation computer program. Optionally, if a solar viewing is possible, a theodolite can be set up and oriented using a solar angle computer program. The calibration person views the crossarm through the theodolite to verify alignment with reference to True North.

2. Once the crossarm is lowered, the person conducting the calibration positions the wind vane exactly parallel to the crossarm and records the reading.

3. Determine accuracy and linearity by mounting a direction template or calibration fixture and fixing the vane in at least the four cardinal directions. The vane is rotated sequentially through at least the four directions clockwise and then counter clockwise and the DAS readouts are recorded. (The tip and then the tail of the vane may also be pointed at established distant sighting targets.)

4. The difference between the station and calibration wind directions is calculated using the following equation:

$$\text{Diff.} = \text{System Wind Direction} - \text{Calibration Wind Direction}$$

The differences calculated above are compared with the EPA PSD recommended criteria of ±5% for the entire system (orientation plus linearity). If results exceed these criteria, the calibration person should recommend recalibration of the sensor or replacement of the potentiometer.

5. Determine starting threshold of the wind vane by measuring shaft rotational torque of the sensor using a torque gauge or disc. The measured torque should be less than the maximum allowable torque provided by the manufacturer corresponding to a 0.5 m/s wind speed threshold.

If the measured torque exceeds this value, the calibrator should recommend bearing and/or potentiometer replacement. If necessary, calculate the torque value that corresponds to the starting threshold of 0.5 m/s for a 10° deflection using the "k" value provided by the manufacturer and the following equation:

$$T = kU^2$$

Where: T = torque in gm-cm

U = wind speed in m/s

and k = constant

The torque gauge test determines if the wind vane starting threshold is less than or equal to the required specifications. The wind vane is considered to be within the recommended criteria if the indicated torque value is less than or equal to the calculated or stated maximum starting torque value. If the wind vane fails the test, the calibrator should recommend that the bearings and/or potentiometer be replaced.

MSI Meteorological Solutions Inc. A Trinity Consultants Company	**STANDARD OPERATING PROCEDURE**	Title: Wind Speed Calibration	
		Number: SOP M12	Page: 1 of 2
		Revision Number: 4	Effective Date: 09/18/2014 06/20/2008 (Rev. 3)
Approval: Date:			Concurred By:

The wind speed calibration will be performed by temporarily replacing the anemometer cups or propeller with a constant RPM or synchronous motor and comparing the speed corresponding to the rotation rate as supplied by the manufacturer with the equivalent wind speed displayed by the instrument. Starting thresholds will be checked using a torque disk or torque watch gauge to measure shaft rotational torque.

Calibration Personnel Responsibilities

The calibration technician is responsible for the certification of the calibration standard before conducting calibrations. The calibration technician will calculate the results of the calibration and will report the preliminary findings to the Project Manager.

Calibration Instrumentation and Forms

The calibration technician will bring the following equipment to the site:

1. RM Young Model 18810 anemometer drive SN CA01889.
2. RM Young Model 18310 Torque Disc.
3. Calibration field data sheets.

Procedures

Calibration procedures conform to the guidelines of the EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV, Version 2.0 Final (EPA, March 2008).

1. Starting threshold is calibrated by checking sensor shaft rotational torque with a torque disc.

   A. <u>R.M. Young Model 18310 Torque Disc</u>

   With the anemometer sensor in the horizontal position, remove the anemometer cups or propeller and install the torque disc on the anemometer shaft. Use manufacturer-provided allowable torque values or calculate the torque value that corresponds to the starting threshold of 0.5 m/s using the "k" value provided by the manufacturer and the following equation:

   $$T = kU^2$$

   Where: T = torque in gm-cm

U = wind speed in m/s

and k = constant (from manufacturer)

Install the 0.1 gm screw weight in the appropriate hole of the torque disc that corresponds to the calculated torque value, and position the weight so that it is level with the anemometer shaft. Release the weight and note if the torque disk and anemometer shaft rotate freely. To measure the actual starting torque, change the position of the screw weight starting at the location closest to the shaft and move outward until the weight rotates freely from the horizontal. The weight of the screw times the distance from the shaft equals the torque in gm-cm.

2. The accuracy of wind speed measurements is tested at zero and at least two speeds within the operational range of the sensor. R.M. Young Model 18810 selectable speed anemometer drive will be used to generate stable calibration input speeds over the range of the sensor.

   The calibration person removes the anemometer cups or propeller and joins the wind speed sensor shaft to the calibration motor with a coupling device.

3. Calculate the difference between the system and calibration wind speeds using the following equation:

   Diff. = System Wind Speed - Calibration Wind Speed

   The differences calculated above are compared with the US EPA PSD recommended criteria of ± 0.2 m/s.

MSi Meteorological Solutions Inc. A Trinity Consultants Company	STANDARD OPERATING PROCEDURE	Title: Relative Humidity Calibration Procedures	
		Number: SOP M15	Page: 1 of 1
		Revision Number: 4	Effective Date: 09/18/2014 06/20/2008 (Rev. 3)
Approval: Date:			Concurred By:

Calibration Personnel Responsibilities

The calibration technician is responsible for the certification of the calibration standard before conducting calibrations. The calibration person will calculate the results of the calibration and will inform the Project manager of the preliminary findings.

Calibration Equipment

- Rotronic or other calibrated digital RH probe - or - a Sato or similar motor aspirated psychrometer.
- Booklet of psychometric tables.
- Water.
- Large plastic bucket (approx. 5 gallon size).
- Calibration forms.
- Portable barometer if using psychometric tables.

Equipment Setup and Calibration Procedures

Calibration procedures are in accordance with the guidelines of the EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV, Version 2.0 Final (EPA, March 2008).

Relative humidity sensors are calibrated using one of two methods.

1. Collocating the station RH sensor and the calibrated RH sensor inside a plastic bucket where water can be added in the bottom of the bucket to provide several different calibration points.

2. Collocating the calibrated RH sensor or motor-aspirated psychrometer adjacent to the site sensor to sense the ambient conditions. Multiple readings are taken over several hours (wet bulb, dry bulb) and converted into RH using the manufacturer's tables.

Data Reduction and Interpretation

Calculate the difference between the station and calibration relative humidity's using the equation:

$$\% \text{ Diff.} = \frac{\text{Station \% RH - Calibration \% RH}}{\text{Calibration \% RH}}$$

The mean of the percent differences calculated above is then compared with the EPA recommended criteria of ±7 percent relative humidity.

Meteorological Solutions Inc. A Trinity Consultants Company	**STANDARD OPERATING PROCEDURE**	Title: Barometric Pressure Calibration	
		Number: SOP M17	Page: 1 of 1
		Revision Number: 3	Effective Date: 09/30/2014 8/27/2007 (Rev. 2)
Approval:		Date:	Concurred By:

Calibration Personnel Responsibilities

The calibration technician is responsible for the certification of the calibration standard before conducting equipment calibrations. The calibration technician will calculate the results of the calibration and informs the Project Manager of the preliminary findings.

Calibration Equipment

- Certified Digital Barometer or digital or aneroid barometer standardized to local National Weather Service reference.

Equipment Setup and Calibration Procedures

Collocate calibration reference barometer with station barometric pressure sensor and record readings for intercomparison.

Data Reduction and Interpretation

Calculate the difference between the station and calibration reference barometric pressure (BP) using the equation:

Difference = Station BP - Calibration BP

The mean of the calculated differences is then compared with the EPA recommended criteria within of ±3 mb of the calibration reference.

APPENDIX D

Quality Assurance/Data Validation Logs and Data Report Quality Assurance Checklist

DATA REPORT
QA CHECKLIST

Client _____
Site Name _____
MSI Project # _____
Report Date _____
Check by: _____

Summary Tables/Data File Check:								
Parameter:	Wind Speed	Wind Direction	Temperature	Relative Humidity	Barometric Pressure	Air Toxics DW	Air Toxics UW	Comments
Verify Missing Data								
Verify Off-Line Periods								
Verify Percent Recovery								
Verify Table Data Calculations								
Report Text Check								
Report Tables Check								
TOC Check								
Data Statistics Check								
Calibration Review								

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DATA INVALIDATION LOG

Project	Date	Time	Parameter	Level	Reason for Invalidation

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DATA VALIDATION SITE ACTIVITY LOG

Site Name:

Activity: **Calibration**
Maintenance
Sensor Replacement
Sensor Malfunction
Performance Audit
Other

Measurement Off-Line

Parameter	Level	From Datalogger Date/Time	To Datalogger Date/Time